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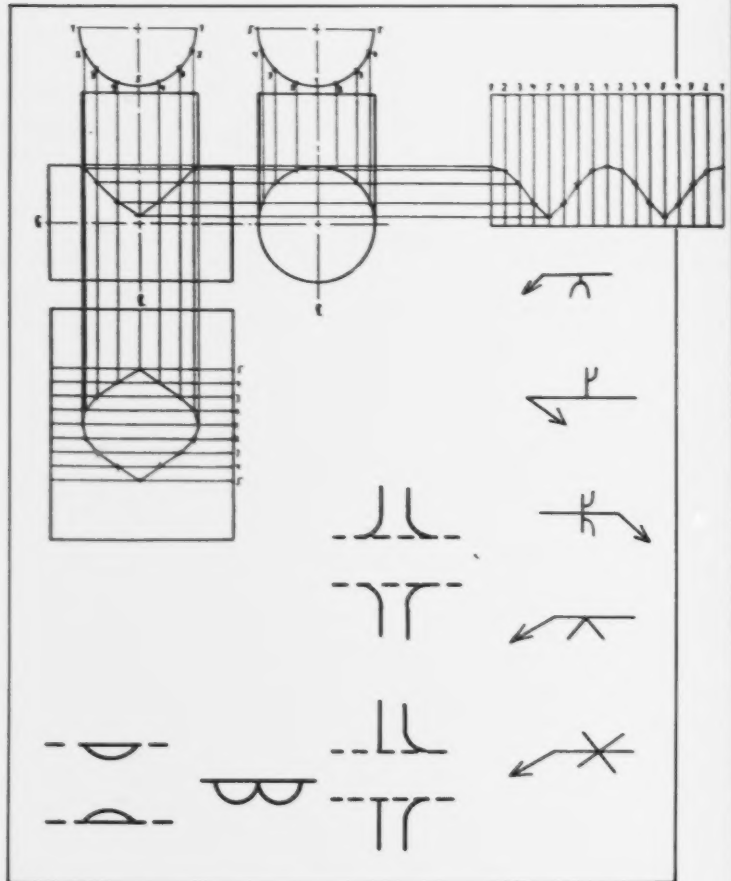
ABSTRACT

This guide is intended to assist vocational educators in teaching a five-unit module in print reading, layout, and fit-up. The module is part of a welding curriculum that has been designed to be totally integrated with Missouri's Vocational Instruction Management System. The following topics are covered in the module: reading basic prints and abbreviations; welding symbols; construction of basic prints and structural shapes; guidelines, true length, and material thickness; and layout on material and pipe fabrication. The materials included in the module have been formatted for competency-based teaching and testing. All information sheets, transparency masters, job sheets, assignment sheets, and test items are keyed to specific competencies, and a cross-reference table has been included to aid in identifying the parts of the curriculum that relate to specific competencies. Unit tests to evaluate specific competencies have also been provided. (MN)

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ELDING • Module 2

Print Reading,
Layout
and
Fit-Up



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CEOS 244

Module: Print Reading, Layout and Fit-Up
Cross-Reference Table of Instructional Materials

Competency	Instructional Objective	Transparency Master	Handout	Assignment Sheet	Job Sheet	Test Item	Notes
B1	I 1.2-1.6	I 1.1	I 1.1, 1.2	I 2.1		I 16-22, 38-45	
B2	I 2.1 II 1.1-1.4, 2.1-2.3	II 1.1-1.3 II 2.1, 2.2	II 1.1, 1.2, 2.1	II 1.1, 2.1-2.3		I 1-15, 23-37, II 1-20	
B3	III 1.1, 1.2	III 1.1, 1.2		III 1.1, 1.2			
B4	III 1.1, 1.2	III 1.1, 1.2		III 1.1, 1.2			
B5	III 2.1-2.3		III 2.1			III 1-30	
D1	IV 1.1-1.4, 2.1, 3.1, V 1.1, 2.1	IV 1.1, 1.2, 2.1	IV 2.1	IV 3.1	IV 1.1, 2.1 V 2.1, 2.2	IV 1-13 V 1-7	
D2	V 2.1	V 1.1-1.3	V 2.1		V 2.3		

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MODULE: BLUEPRINT READING, LAYOUT AND FIT-UP

UNIT I: READING BASIC PRINTS AND ABBREVIATIONS

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to differentiate between various types of drawings, interpret basic prints, identify parts of and abbreviations on a print, and discuss reasons for scaling prints. This knowledge will be evidenced by achieving the specified score on the unit test.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

- 1.1 State the purpose and use of blueprints.
- 1.2 Differentiate between blueprints and blue-line drawings.
- 1.3 Differentiate between three-view and pictorial drawings.
- 1.4 State the purpose of title blocks and revision blocks.
- 1.5 Identify types of lines used on drawings.
- 1.6 Interpret basic prints.
- 2.1 Identify common abbreviations found on blueprints.

MODULE: BLUEPRINT READING, LAYOUT AND FIT-UP
UNIT I: READING BASIC PRINTS AND ABBREVIATIONS
CONTENTS OF THIS UNIT

- A. Objective sheet
- B. References
- C. Notes to the instructor
- D. Lesson plans
 - 1. Lesson 1: READING BASIC PRINTS
 - a. Information outline
 - b. Transparency master
 - TM 1.1: Types of lines
 - c. Handouts
 - HO 1.1: Generic print (three-view and pictorial)
 - HO 1.2: Sample print
 - 2. Lesson 2: ABBREVIATIONS FOR PRINTS
 - a. Information outline
 - b. Assignment sheet
 - AS 2.1: Sketch interpretation
- E. Unit test
- F. Answers to unit test

REFERENCES

- A. Books
 - 1. Giachino, Joseph and William Weeks. Welding Skills and Practices. Chicago: American Technical Publishers, Inc., 1976.
 - 2. Horwitz, Henry. Welding Principles and Practice. Boston: Houghton Mifflin Company, 1979.
 - 3. Sacks, J. Raymond. Welding Principles and Practices. Peoria, Ill.: Charles A. Bennett Co., Inc., 1976.

B. Curriculum guide

1. Fortney, Clarence, and Mike Gregory. Blueprint Reading and Layout for Welding. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

NOTES TO INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Lecture on the uses and reasons for blueprints, pointing out the types of prints.
2. Invite a drafting instructor to present an interpretation of blueprints.
3. Arrange a field trip to a local manufacturing plant where students can trace prints from the drafting table to the finished project.

B. Suggested student activities

1. Have students select an object, then draw a three-view drawing, pictorial projection and sectional view of it.
2. Have students make shop drawings of five small projects they could make later in the year.

C. Suggested supplemental materials

1. Welding Supplementary Units. Columbia: Instructional Materials Laboratory, University of Missouri-Columbia, 1988.

MODULE: BLUEPRINT READING, LAYOUT AND FIT-UP
UNIT I: READING BASIC PRINTS AND ABBREVIATIONS
LESSON 1: READING BASIC PRINTS

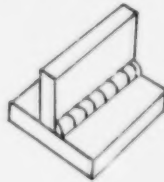
- I. Explanation of why prints are used
 - A. Sign language of the industry
 - B. Universal language
- II. Blueprints and blue-line drawings
 - A. Blueprints
 - 1. Blue background with white lines
 - a. Easy on the eyes
 - b. Don't soil easily
 - 2. Photographic process
 - a. Fade easily
 - b. Shrinks paper so scaling to close tolerances is impossible
 - B. Blue-line drawing
 - 1. White background with blue lines
 - a. Pencil notes are easily read
 - b. Neat looking; easy to read
 - 2. Double wet photographic process
 - a. Greater shrinkage than that of blueprint
 - b. Very difficult to keep clean in field or shop
- III. Blueprint as a whole
 - A. Three-view drawing (HO 1.1)
 - 1. Shows all three views of an object
 - 2. Gives viewer better idea of detail of top, side and end views
 - 3. Used in cases where great detail must be applied

4. Makes a complicated object easier to read



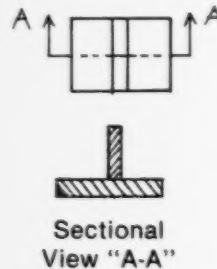
B. Pictorial projection

1. Shows what a finished product looks like in a three-dimensional view as the viewer conceives it; shows top, side and front views in one drawing
2. Pictorials can be used more than once. For example, one may show front, top and side views while another shows bottom, back and end views.



C. Sectional views

1. Shows viewer what the object would look like if it were "cut" through (as if sawed in half)
2. Used to make hidden or complicated details easier to understand.
3. Sometimes used as a detailed sectional view



IV. Title blocks and revision blocks (HO 1.2)

A. Title blocks

1. Can be located anywhere on blueprint, such as across the bottom, top or in any of the four corners
2. Information included
 - a. Number of particular piece(s) required for the finished product
 - b. Part number
 - c. Description or name of part
 - d. Size of part
 - e. Material type
 - f. Specifications

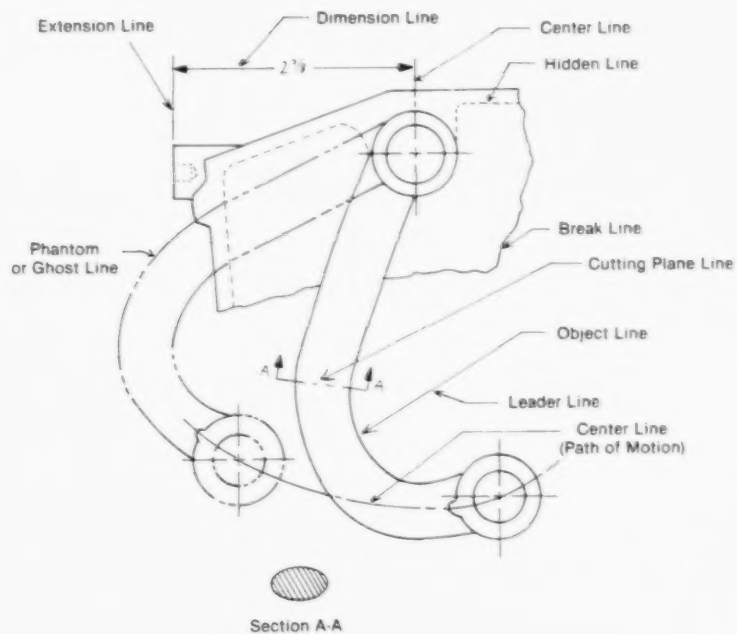
- g. Tolerance limits
- h. Print name
- i. Scale of drawing
- j. Finished part number

B. Revision blocks

1. Tell viewer of any changes made in print
 - a. When revision was made (date)
 - b. By whom revision was made
2. Important because many times a draftsman or supervisor will change something about a print--such as measurement, tolerance or location--and not change the print itself

V. Lines on a print (TM 1.1)

- A. Border
- B. Object
- C. Hidden
- D. Break
- E. Phantom or ghost
- F. Extension
- G. Dimension
- H. Leader
- I. Cutting plane
- J. Center



VI. Dimensions and scale

- A. Dimensions
 1. Whole numbers
 2. Fractions
 3. Decimals

4. Metric (not widely used in U.S.)

B. Scale

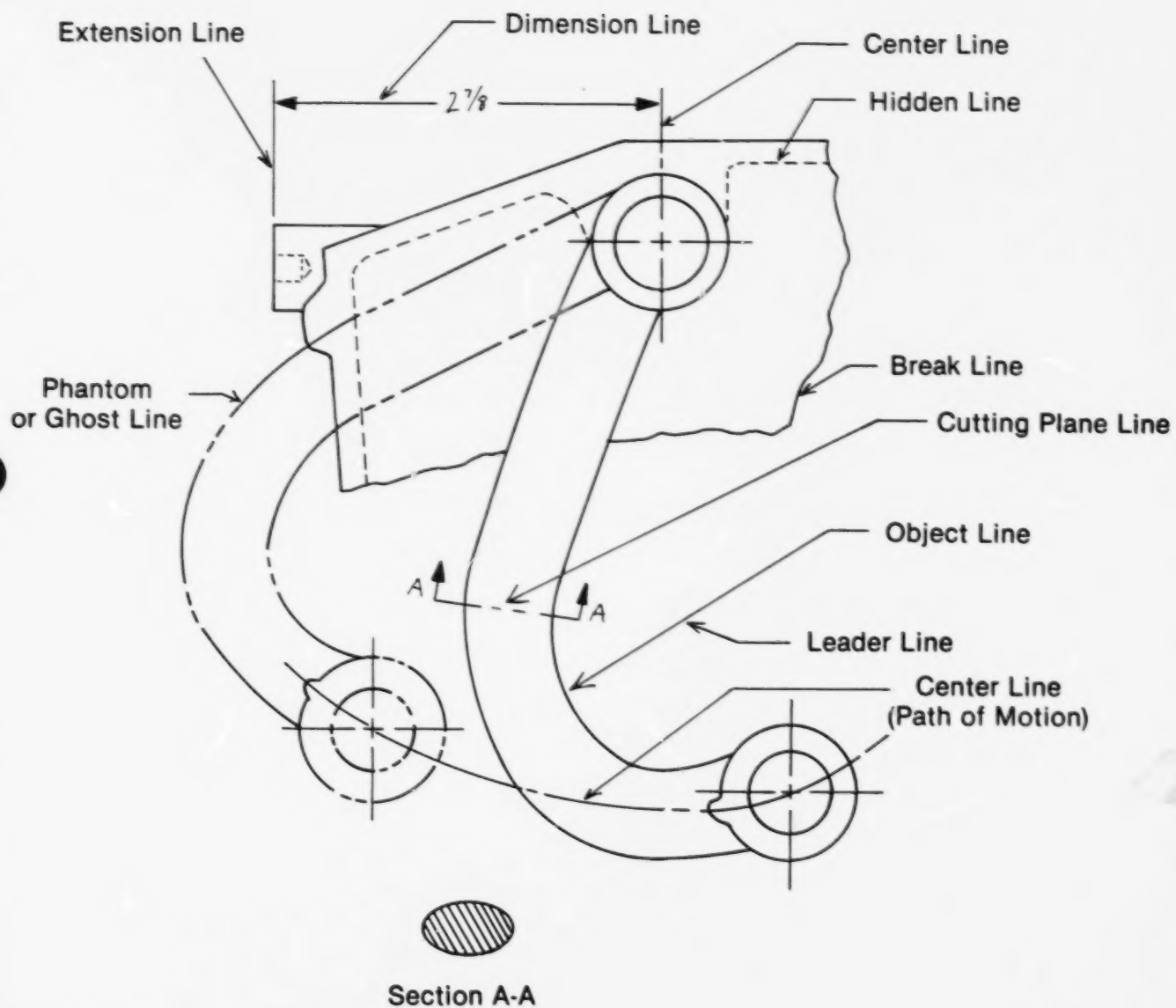
1. Reasons for scaling

- a. Sometimes scaled down (make large pieces smaller on print)
- b. Sometimes scaled up (make small pieces larger on print)

2. Scaling methods

- a. Whole-number scale (1 to 4)
- b. Fractional scale ($1/4" = 1"$ or $1/2" = 1"$)
- c. Actual scale (1 to 1)
- d. Drawing not to scale

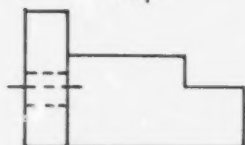
TYPES OF LINES



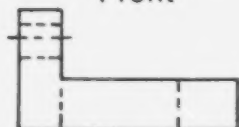
GENERIC PRINT (THREE-VIEW AND PICTORIAL)

3 View Drawing

Top



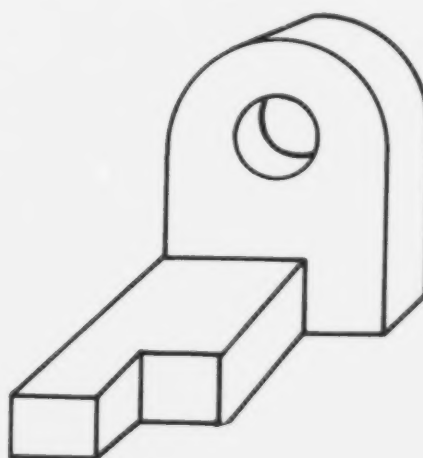
Front



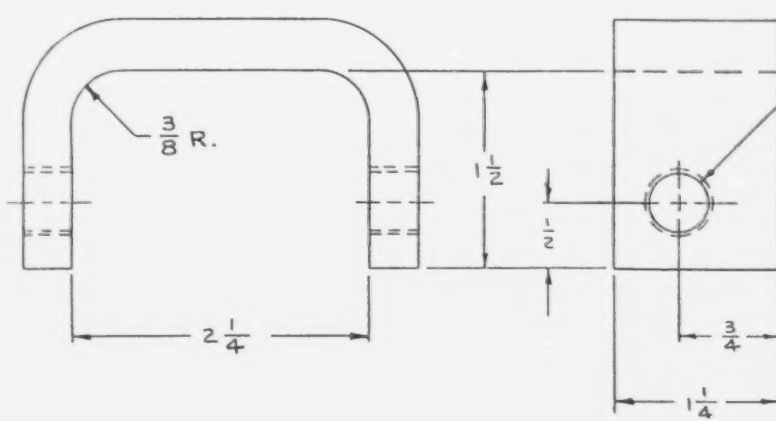
Right Side



Pictorial



		SYM	REVISION	A	007-2813
				OWN CHK	DATE



DRILL $\frac{27}{64}$ DIA.
TAP $\frac{1}{2}$ -13 UNC-2B
TYP. EACH SIDE

				3/8 x 1 1/4 H. R. STEEL BAR	
	ITEM	PART NO	DESCRIPTION		REQD
LIST OF MATERIALS					
	DRAWN D.W.H.	DATE 2-9-84	SCALE FULL	Snorkel DIVISION OF A.T.O INC	
	APPROVED <i>Heel</i>	ER 4592	WEIGHT .7 #		
13	D-007-2556	1	DO NOT SCALE THIS PRINT TOLERANCES UNLESS NOTED FRACTIONS - 1/16 ANGLES - 1° REPORT ALL ERRORS TO ENGINEERING DEPARTMENT		
ITEM	NEXT DWG NO	REQD	TITLE TORQUE BAR LOCK MOUNTING FRAME SNORKELIFT SIZE A DRAWING NO. 007-2813		

SAMPLE PRINT

HO 1.2

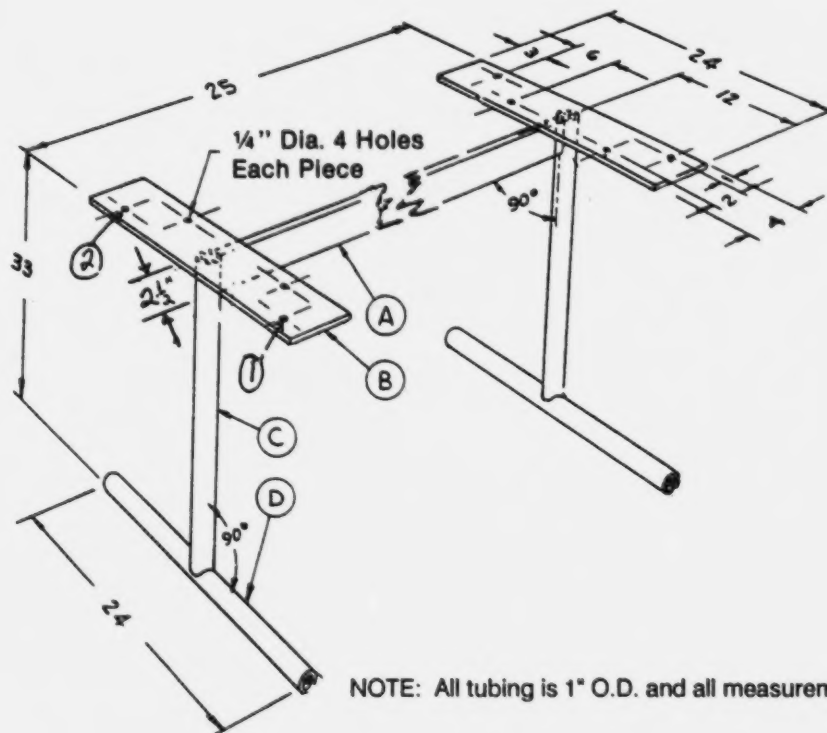
P.R. L&F 13

MODULE: BLUEPRINT READING, LAYOUT AND FIT-UP
UNIT I: READING BASIC PRINTS AND ABBREVIATIONS
LESSON 2: ABBREVIATIONS FOR PRINTS

- I. Common blueprint abbreviations
 - A. C.I. = Cast iron
 - B. C.C. = Center to center
 - C. C. bore = Counter bore
 - D. C.R.S. = Cold rolled steel
 - E. C.S. = Cast steel
 - F. Csk = Countersink
 - G. Dia. = Diameter
 - H. F or Fin = Finish
 - I. F.A.O. = Finish all over
 - J. F.S. = Full size
 - K. F.S.D. = Full size detail
 - L. Hex = Hexagon
 - M. I.D. = Inside diameter
 - N. N.C. = National course
 - O. N.F. = National fine
 - P. # or No. = Number
 - Q. O.C. = On center
 - R. O.D. = Outer diameter
 - S. R or Rad = Radius
 - T. Req'd = Required
 - U. S.A.E. = Society Automotive Engineers
 - V. Sq. = Square
 - W. U.S.S. = United States Standard

X. N.T.S. = Not to scale
Y. Cir. = Circular
Z. Cyl. = Cylinder
AA. Deg or = Degrees
BB. Ga. = Gauge
CC. G.I. = Galvanized iron
DD. I = I-beam
EE. In. or " = Inches
FF. Mal I = Malleable iron
GG. Std. = Standard
HH. Stl. = Steel
II. Stl. C = Steel casting
JJ. Thd. or Thds. = Thread(s)
KK. W.I. = Wrought iron
LL. Br# = Brass, SAE#
MM. Bro# = Bronze, SAE#
NN. Chfr. = Chamfer
OO. Typ. = Typical
PP. ϕ = Center line
QQ. PL or $\overline{P}$ = Plate
RR. Sch. = Schedule

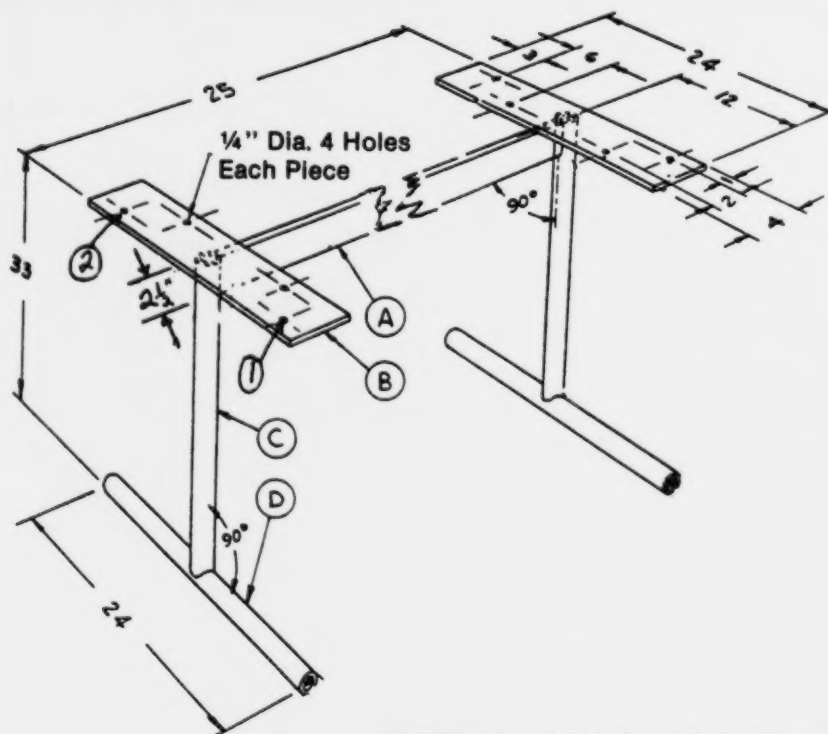
SKETCH INTERPRETATION



NOTE: All tubing is 1" O.D. and all measurements are in inches.

Answer these 12 questions about the drawing above.

1. How tall is the table frame? ____
2. How wide is the table frame? ____
3. How wide is Part A? ____
4. What size drill bit would be needed to drill the holes in Part B? ____
5. What degree angle is formed between Parts A and C? ____
6. What is the outside diameter of Part D? ____
7. What is the length of Part D? ____
8. What is the distance between hole #1 and hole #2? ____



NOTE: All tubing is 1" O.D. and all measurements are in inches.

9. How far is hole #1 from the left side of Part B? ____
10. How far is hole #2 from the right side of Part B? ____
11. What type of drawing is this? ____
12. Is this drawing to scale? ____ Explain your answer.

INSTRUCTOR'S NOTE: Completion of this assignment sheet and the unit test to specified score are the student's final evaluation for competency B1: Read and interpret basic prints.

ANSWERS TO ASSIGNMENT SHEET 2.1

1. 33"
2. 25"
3. $2\frac{1}{2}$ "
4. $\frac{1}{4}$ "
5. 90°
6. 1"
7. 24"
8. 18"
9. 1"
10. 3"
11. Pictorial
12. No. (NOTE: Explanations will vary.) Because the written dimensions do not correspond to the dimensions of the object as drawn. For example, according to the written dimensions, the table frame is taller than it is wide. However, the table frame is drawn so that the height is less than the width.

MODULE: BLUEPRINT READING, LAYOUT AND FIT-UP

UNIT I: READING BASIC PRINTS AND ABBREVIATIONS

UNIT TEST

Match abbreviations with meanings by placing the letter of the appropriate meaning in the blank before the abbreviation.

- | | |
|--|-----------------------|
| ___ 1. Chfr. | a. Cast iron |
| ___ 2. C.I. | b. Cast steel |
| ___ 3. C.C. | c. Center line |
| ___ 4. C.R.S. | d. Center to center |
| ___ 5.  | e. Chamfer |
| ___ 6. C. bore | ab. Circular |
| ___ 7. Csk | ac. Cold rolled steel |
| ___ 8. G.I. | ad. Counter bore |
| ___ 9. I.D. | ae. Countersink |
| ___ 10. C.S. | bc. Finish all over |
| ___ 11. Cir. | bd. Full size detail |
| ___ 12. F.S.D. | be. Galvanized iron |
| ___ 13. I | cd. Gauge |
| ___ 14. F.A.O. | ce. Inside diameter |
| ___ 15. Ga. | de. I-beam |

Select the option which best completes the statement or answers the question.

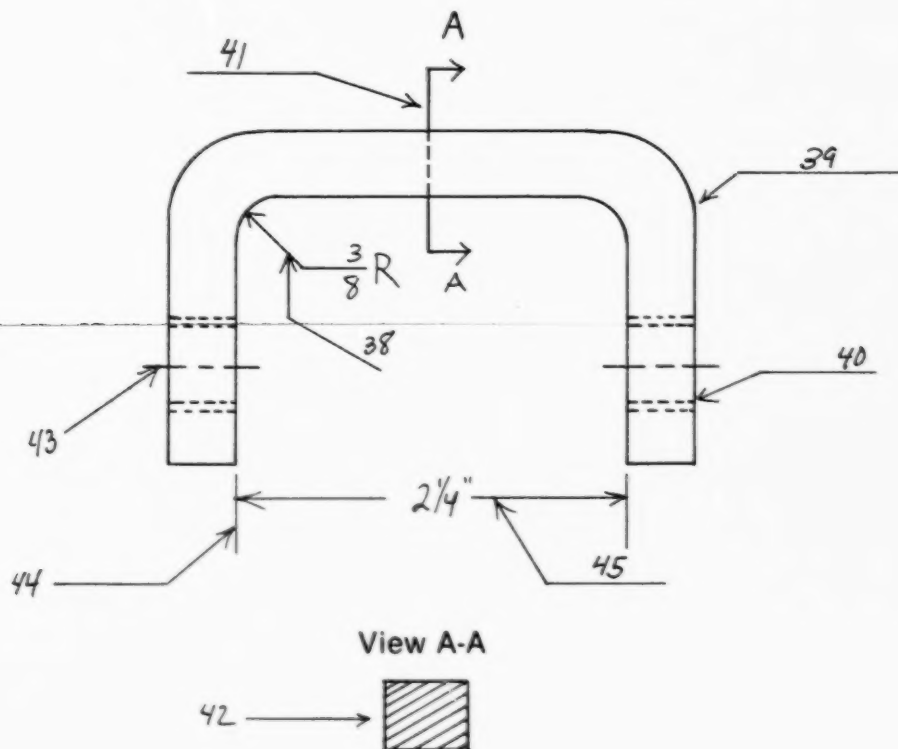
- ___ 16. Blueprints are called the ___ of the industry.
- a. Sign language
 - b. Working signs
 - c. Foundation
 - d. Guidelines
- ___ 17. Which is a true statement about blueprints?
- a. Different symbols are used east and west of the Mississippi.
 - b. Dimensioning methods vary east and west of the Mississippi.
 - c. Blueprints are standardized worldwide.
 - d. A true blueprint has blue lines with a white background.

- ___ 18. Which of the following prints fades easiest?
- a. Blueprint
 - b. Shop sketch
 - c. Engineer's note
 - d. Blue-line drawing
- ___ 19. Which type of drawing shows an object in a three-dimensional manner?
- a. Blue line
 - b. Pictorial
 - c. Sectional
 - d. Three-view
- ___ 20. Which type of drawing is used when a great amount of detail must be shown?
- a. Sectional
 - b. Pictorial
 - c. Multipurpose
 - d. Three-view
- ___ 21. This block contains information such as the part number, scale and part name.
- a. Title
 - b. Information
 - c. Revision
 - d. Note
- ___ 22. This block tells of any changes made in the print.
- a. Title
 - b. Information
 - c. Revision
 - d. Note

Match abbreviations with meanings by placing the letter of the appropriate meaning in the blank before the abbreviation.

- | | |
|-----------------------|----------------------------------|
| ___ 23. O.D. | a. Malleable iron |
| ___ 24. N.C. | b. National course |
| ___ 25. U.S.S. | c. National fine |
| ___ 26. Typ. | d. Not to scale |
| ___ 27. S.A.E. | e. On center |
| ___ 28. N.F. | ab. Outer diameter |
| ___ 29. Thd. or Thds. | ac. Schedule |
| ___ 30. Mal l | ad. Society Automotive Engineers |
| ___ 31. O.C. | ae. Standard |
| ___ 32. Sch. | bc. Steel |
| ___ 33. W.I. | bd. Steel casting |
| ___ 34. Std. | be. Thread(s) |
| ___ 35. N.T.S. | cd. Typical |
| ___ 36. Stl. C | ce. Wrought iron |
| ___ 37. Stl. | de. United States Standard |

Identify the lines on the drawing below by matching the illustrations to appropriate letters from the list that follows.



- a. Center line
- b. Cutting plane
- c. Dimension
- d. Extension

- e. Hidden
- ab. Leader
- ac. Object
- ad. Sectional view and lines

- 38. _____
- 39. _____
- 40. _____
- 41. _____

- 42. _____
- 43. _____
- 44. _____
- 45. _____

INSTRUCTOR'S NOTE: Completion of AS 2.1 and this unit test to specified score are the student's final evaluation for competency B1: Read and interpret basic prints.

ANSWERS TO UNIT TEST

1. e (B2)
2. a (B2)
3. d (B2)
4. ac (B2)
5. c (B2)
6. ad (B2)
7. ae (B2)
8. be (B2)
9. ce (B2)
10. b (B2)
11. ab (B2)
12. bd (B2)
13. de (B2)
14. bc (B2)
15. cd (B2)
16. a (B1)
17. c (B1)
18. a (B1)
19. b (B1)
20. d (B1)
21. a (B1)
22. c (B1)
23. ab (B2)

24. b (B2)
25. de (B2)
26. cd (B2)
27. ad (B2)
28. c (B2)
29. be (B2)
30. a (B2)
31. e (B2)
32. ac (B2)
33. ce (B2)
34. ae (B2)
35. d (B2)
36. bd (B2)
37. bc (B2)
38. ab (B1)
39. ac (B1)
40. e (B1)
41. b (B1)
42. ad (B1)
43. a (B1)
44. d (B1)
45. c (B1)

MODULE: BLUEPRINT READING, LAYOUT & FIT-UP

UNIT II: WELDING SYMBOLS

UNIT OBJECTIVES

Upon completion of this unit, the student should be able to identify weldment symbols and related data; differentiate between the types of intermittent weldment; understand weldment contour; identify basic types of weldment joints; identify welding groove types; and identify piece grooving information. This knowledge will be evidenced by achieving the specified score on the unit test.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

- 1.1 Identify the five basic types of weld joints.
- 1.2 Identify reasons for and methods of grooving material.
- 1.3 Differentiate between the types of grooves in welding.
- 1.4 Identify particular piece grooving information.
- 2.1 Correctly identify information given on reference lines.
- 2.2 Translate written welding information into correct symbol form.
- 2.3 Translate welding symbols into written form.

MODULE: BLUEPRINT READING, LAYOUT & FIT-UP

UNIT II: WELDING SYMBOLS

CONTENTS OF THIS UNIT

- A. Objective sheet
- B. Notes to the instructor
- C. References
- D. Lesson plans
 - 1. Lesson 1: JOINT TYPES AND GROOVE SYMBOLS
 - a. Information outline
 - b. Transparency masters
 - TM 1.1: Basic types of joints
 - TM 1.2: General groove symbols
 - TM 1.3: General welding symbols
 - c. Handouts
 - HO 1.1: Basic types of joints
 - HO 1.2: General welding and groove symbols
 - HO 1.3: Location of welding symbols
 - d. Assignment sheet
 - AS 1.1: Identify joint types and groove symbols
 - e. Answers to assignment sheet
 - 2. Lesson 2: BASIC WELDING SYMBOLS
 - a. Information outline
 - b. Transparency masters
 - TM 2.1: Reference line—both sides
 - TM 2.2: Weld symbols
 - c. Assignment sheets
 - AS 2.1: Weldment size and location
 - AS 2.2: Translating welding symbols
 - AS 2.3: Translating from welding symbols
 - d. Answers to assignment sheets

- E. Unit test
- F. Answers to unit test

REFERENCES

A. Books

1. Giachino, Joseph and William Weeks. Welding Skills and Practices. Chicago: American Technical Publishers, Inc., 1976.
2. Horwitz, Henry. Welding Principles and Practice. Boston: Houghton Mifflin Company, 1979.
3. Sacks, J. Raymond. Welding Principles and Practices. Peoria, Ill.: Charles A. Bennett Co., Inc., 1976.

B. Curriculum guide

1. Fortney, Clarence, and Mike Gregory. Blueprint Reading and Layout for Welding. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. (TM 2.1) Draw reference lines and arrow leaders different ways so students don't get the impression that there is only one correct way to draw them.
2. Obtain samples of the five basic types of weldment joints, using them to illustrate the purpose of welding symbols.

B. Suggested student activities

1. Using the five small project prints made in the previous unit, students can complete proper symbols for each plan.

C. Suggested supplemental materials

1. Welding Supplementary Units. Columbia: Instructional Materials Laboratory, University of Missouri-Columbia, 1968.
2. Orthographic Projection, Visualization and Dimension of Weldment Prints (W-78-150). Sedalia, Mo.: The Media Center, State Fair Community College, 1978.
3. Basic Joints Used in Welding (W-77-106). Sedalia, Mo.: The Media Center, State Fair Community College, 1977.

MODULE: BLUEPRINT READING, LAYOUT & FIT-UP

UNIT II: WELDING SYMBOLS

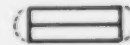
LESSON 1: JOINT TYPES AND GROOVE SYMBOLS

I. Types (names) of joints (TM 1.1, HO 1.1)

A. Butt



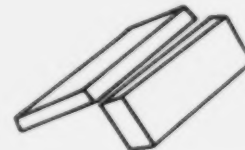
D. Edge



B. Lap



E. Corner



C. T



II. Groove joints (TM 1.2, HO 1.2)

A. Reasons for grooving material

1. Better strength
2. Less chance of weldment failure

B. Methods of grooving (grinding, sawing, machining)

- b. Sawing
- c. Machining

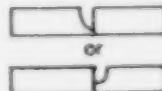
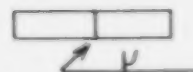
NOTE: It is important to remember that grooves can be made on either the arrow side, the other side or both. Students should begin to develop the ability to tell which side receives the groove.



Correct



Incorrect



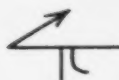
PrR, L&F 31

NOTE: First determine whether the symbol is on the arrow or other side. Secondly, determine the side the arrow points to, not the piece.

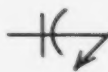
III. Groove symbols (TM 1.3, HO 1.3)

Name	Symbol	Actual appearance
A. Square		
B. Bevel		
C. Double bevel		
D. V		
E. Double V		
F. J		
G. Double J		
H. U		
I. Double U		

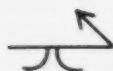
J. Flare bevel



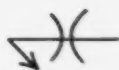
K. Double flare bevel



L. Flare V



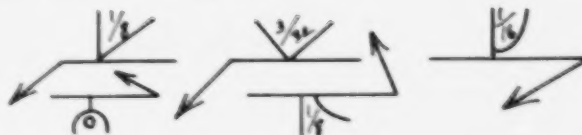
M. Double flare V



IV. Grooving information

A. Root opening (gap)

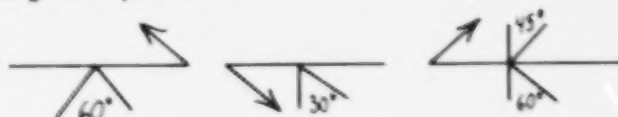
1. Location on groove symbol is in groove symbol as close to reference line as possible.



2. Usually given in fractions because it would take excessive room to print in decimals

B. Groove angle

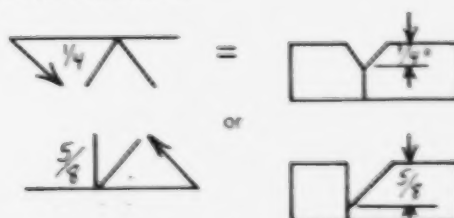
1. Located at opening of groove symbol



2. Somewhat limited to straight cut bevels or edges
3. Given in degrees (Js and Us are an exception to the rule.)

C. Depth of grooving

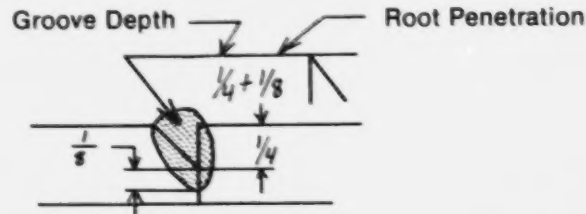
1. Located to left side of groove symbol



2. It is now possible to see that not all beveling or grooving is to be throughout a piece, but can be partial depth of plate.

D. Root penetration

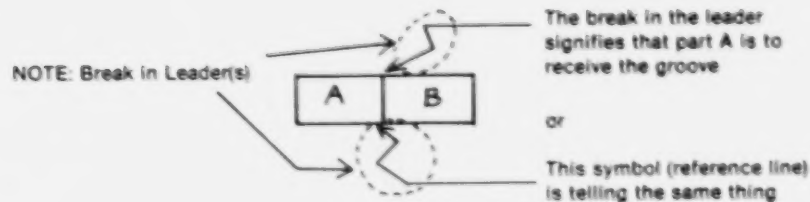
1. Located to the right of groove depth information but to the left of symbol; is always preceded by a plus (+) sign



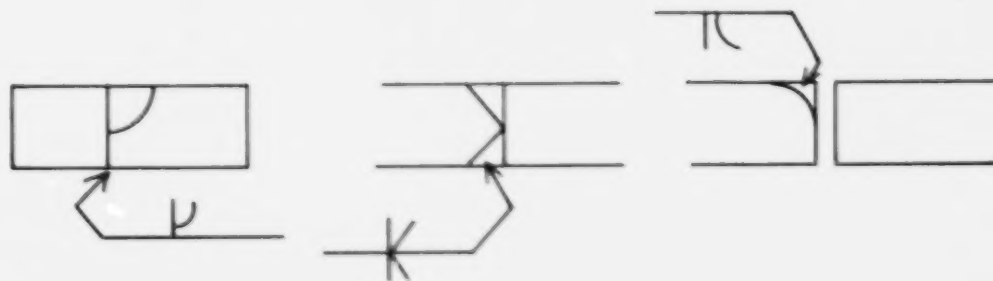
2. Root penetration is the amount of penetration beyond the depth of the groove and not top or face-side build-up.

E. Particular piece grooving

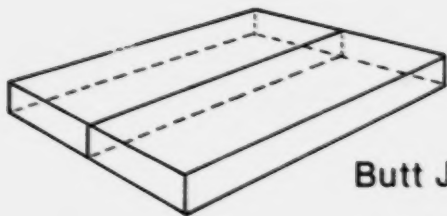
1. In many cases it is important to put the groove on a particular piece of a joint. This is pointed out by a break in the arrow leader.
2. Note the break in leaders pointing to parts A and B. Shown at the piece's top or bottom, the break in the leader signifies that part A is to receive the groove.



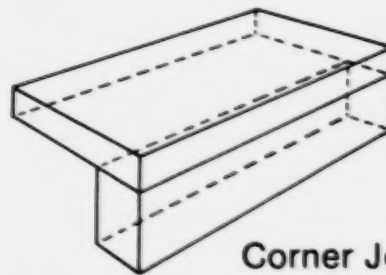
Simple Examples



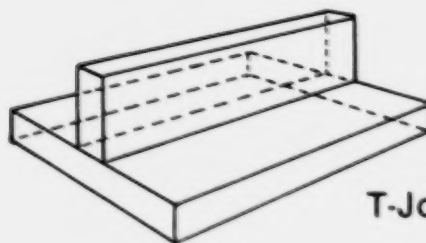
BASIC TYPES OF JOINTS



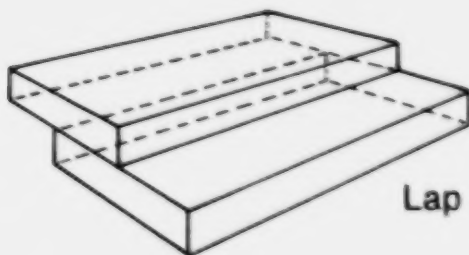
Butt Joint



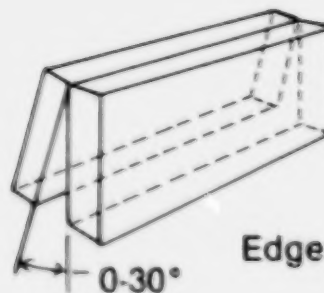
Corner Joint



T-Joint

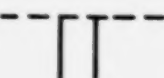


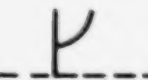
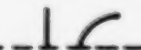
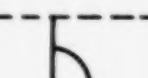
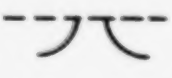
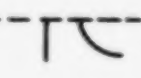
Lap Joint



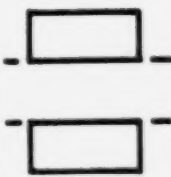
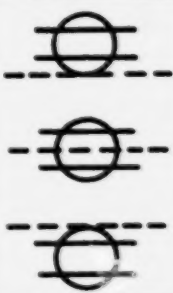
Edge Joint

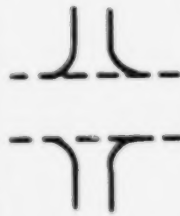
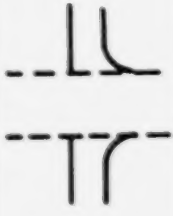
GENERAL GROOVE SYMBOLS

Square	Scarf	V	Bevel
			
			

U	J	Flare-V	Flare-Bevel
			
			

GENERAL WELDING SYMBOLS

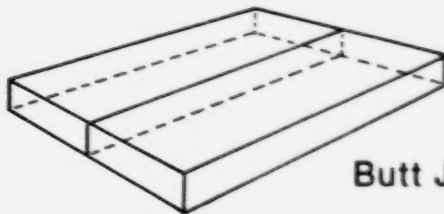
Fillet	Plug or Slot	Spot or Projection	Seam
			

Back or backing	Surfacing	Flange	
		Edge	Corner
			

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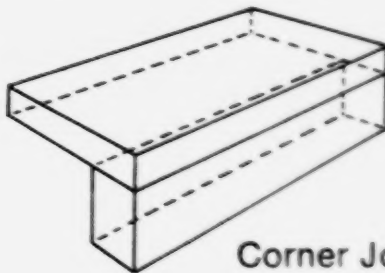
BASIC TYPES OF JOINTS



Butt Joint

Applicable Welds

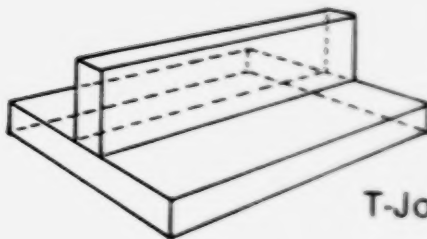
Square-Groove	J-Groove
V-Groove	Flare V-Groove
Bevel-Groove	Flare-Bevel-Groove
U-Groove	Edge-Flange
	Braze



Corner Joint

Applicable Welds

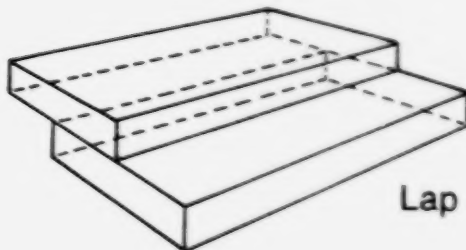
Fillet	Flare-Bevel-Groove
Square-Groove	Edge-Flange
V-Groove	Corner-Flange
Bevel-Groove	Spot
U-Groove	Projection
J-Groove	Seam
Flare V-Groove	Braze
Plug	Slot



T-Joint

Applicable Welds

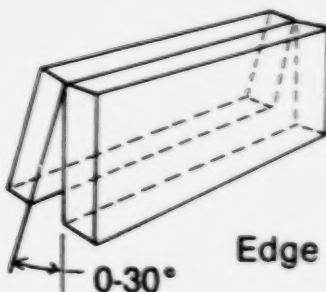
Fillet	J-Groove
Plug	Flare-Bevel-Groove
Slot	Spot
Square-Groove	Projection
Bevel-Groove	Seam
	Braze



Lap Joint

Applicable Welds

Fillet	J-Groove
Plug	Flare-Bevel-Groove
Slot	Spot
Bevel-Groove	Projection
	Seam
	Braze

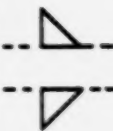
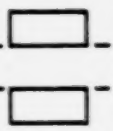
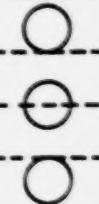
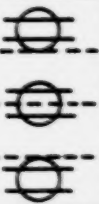
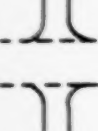
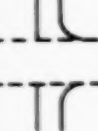


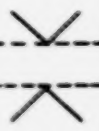
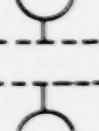
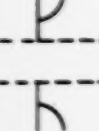
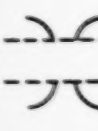
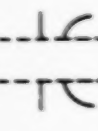
Edge Joint

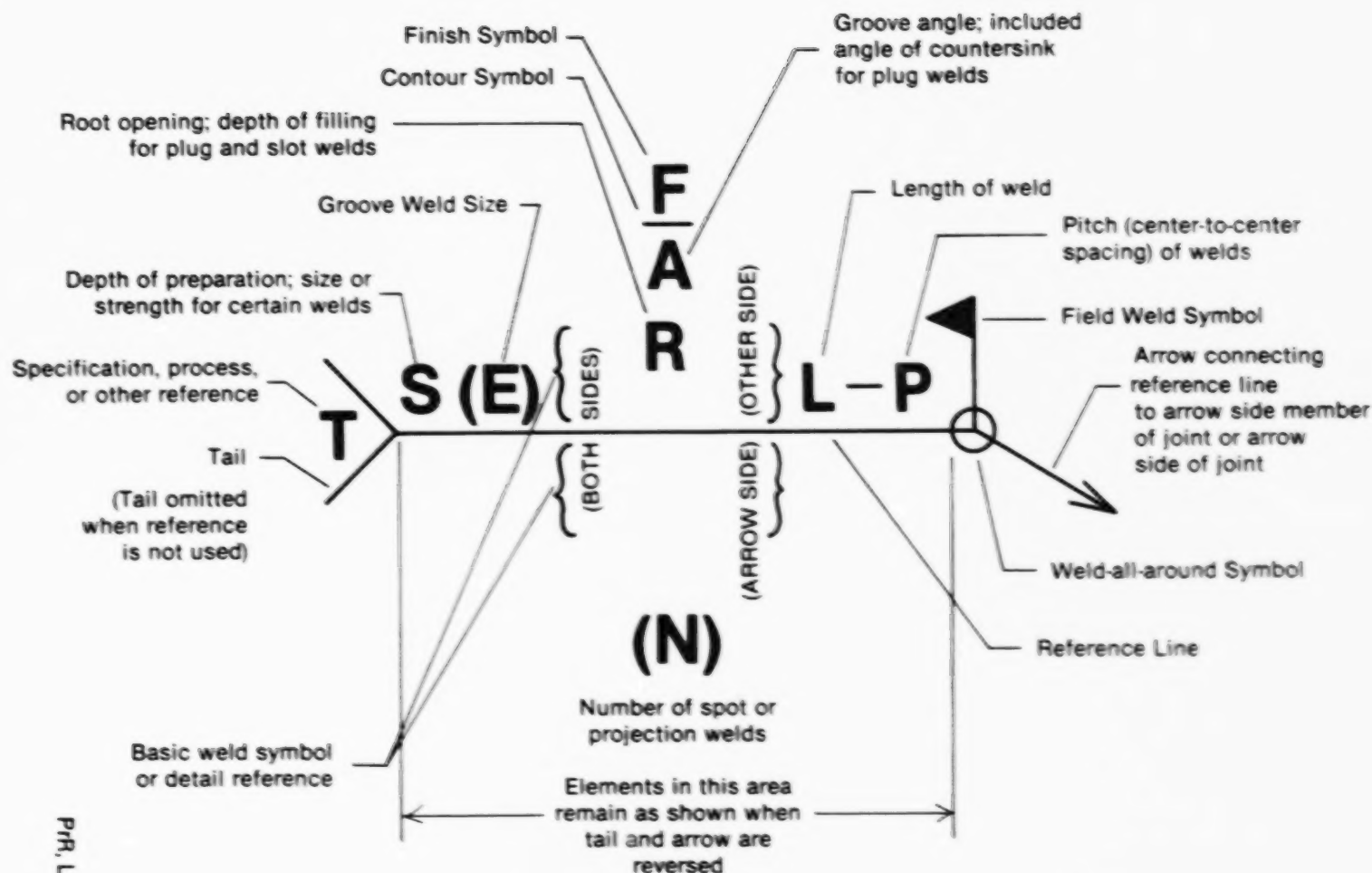
Applicable Welds

Square-Groove	Edge-Flange
Bevel-Groove	Corner-Flange
V-Groove	Seam
U-Groove	Edge
J-Groove	

GENERAL WELDING AND GROOVE SYMBOLS

Fillet	Plug or Slot	Spot or Projection	Seam	Back or backing	Surfacing	Flange	
						Edge	Corner
							

Square	Scarf	V	Bevel	U	J	Flare-V	Flare-Bevel
							



LOCATION OF WELDING SYMBOLS

HO 1.3

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IDENTIFY JOINT TYPES AND GROOVE SYMBOLS

For each illustration, identify joint type/name and groove type/name by placing the letter of the appropriate choice in the blank. Then draw the groove symbol on the reference line.

Joint type
or name

- a. Butt
- b. Corner
- c. Edge
- d. Lap
- e. T

Groove type or name

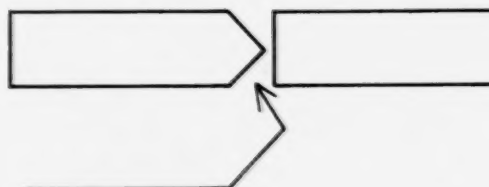
- ab. Bevel
- ac. Double bevel
- ad. Double J
- ae. Double V
- bc. Flare-V
- bd. J
- be. Square
- cd. U
- ce. V

Example:

a ce



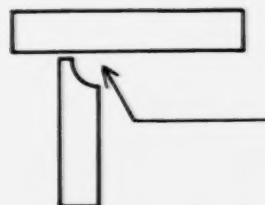
1. _____ 2. _____



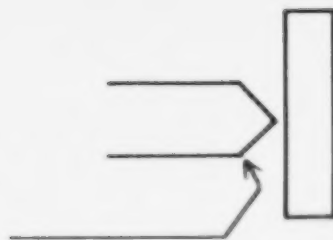
4. _____ 5. _____



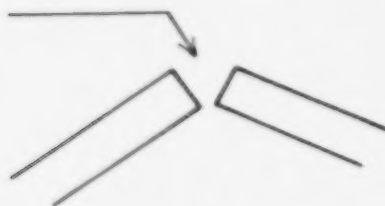
7. _____ 8. _____



10. ____ 11. ____



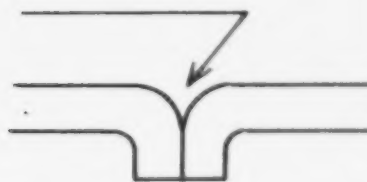
13. ____ 14. ____



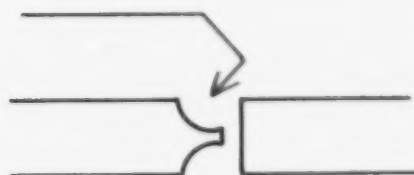
16. ____ 17. ____



19. ____ 20. ____



22. ____ 23. ____



25. ____ 26. ____

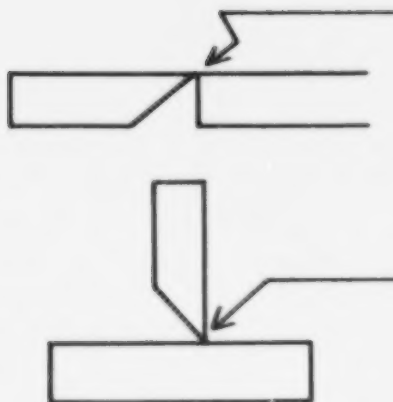


28. ____ 29. ____



31. _____ 32. _____

34. _____ 35. _____



ANSWERS TO ASSIGNMENT SHEET 1.1

1. a

2. ac



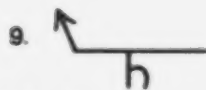
4. a

5. cd



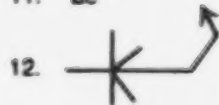
7. e

8. bd



10. e

11. ac



13. b

14. ce



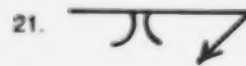
16. c

17. ce



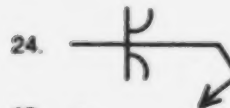
19. c

20. bc



22. a

23. ad



25. a

26. ae



28. d

29. ab



31. a

32. ab



34. e

35. ab



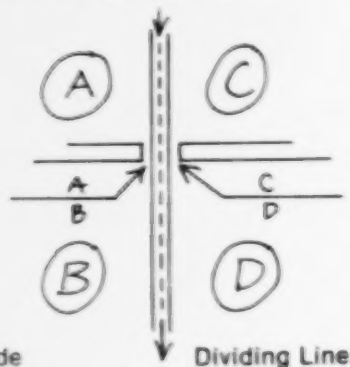
MODULE: BLUEPRINT READING, LAYOUT & FIT-UP

UNIT II: WELDING SYMBOLS

LESSON 2: BASIC WELDING SYMBOLS

I. Reference line and arrow leader

- A. Location on print (anywhere on horizontal position)
- B. Arrow side (side or point where arrow head ends)
- C. Other side (side or point in a given joint that does not have arrow head on it)
- D. Special circumstances



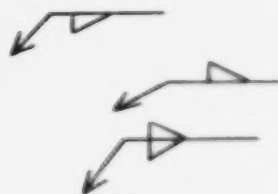
E. Reasons why all instructions are not given on arrow side

- 1. No room for reference line in particular location
- 2. If both sides of joint receive weldments, then one reference line can give the information for both. This keeps the print less cluttered.

II. Weldment symbols

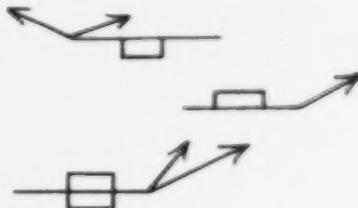
A. Fillet weld

- 1. Arrow side
- 2. Other side
- 3. Both sides



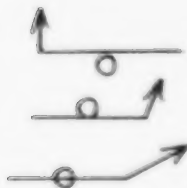
B. Plug or slot weld

- 1. Arrow side
- 2. Other side
- 3. Both sides



C. Spot welds

1. Arrow side
2. Other side
3. Both sides

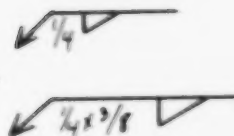


III. Detailing weldment information

A. Fillet welds

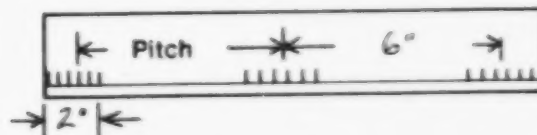
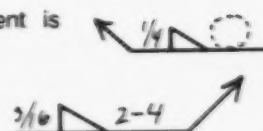
1. Weldment size

- a. Weldment size refers to leg length, not to face size.
- b. Unequal leg lengths (One leg must be shown on print so viewer can tell which leg goes to a particular piece.)
- c. Location of weldment size (just to the left of fillet weld symbol)



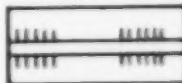
2. Weldment length and pitch

- a. Length is located to right of symbol. If left blank, weldment is continuous.
- b. Intermittent welds (illus. shows 2" weldment on 4" pitch.)
3. Pitch is the center-to-center measurement from one weldment to the next weldment in an intermittent weld.

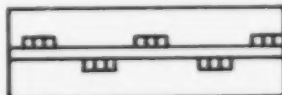


4. Intermittent welds

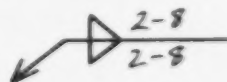
- a. Chain intermittent (intermittent welds are aligned across from each other)



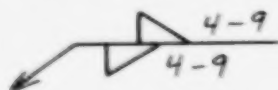
- b. Staggered intermittent (intermittent welds do not align)



- c. Weld symbol for chain intermittent welds

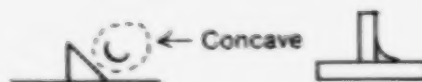


- d. Weld symbols for staggered intermittent welds

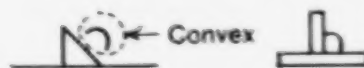


5. Weldment contour symbols

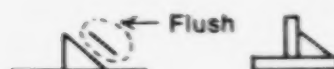
- a. Concave



- b. Convex



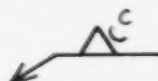
- c. Flush



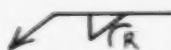
6. Methods of obtaining contour

- a. If area above contour symbol is blank, contour is to be achieved by welding

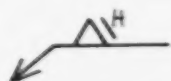
- b. C = chipping



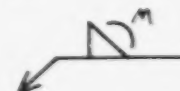
- c. R = rolling



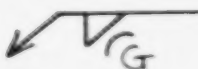
- d. H = hammering



- e. M = machining



- f. G = grinding



7. Reference line tail

- a. Gives information in addition to symbols, such as:

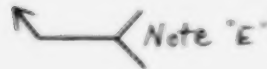
Process to use



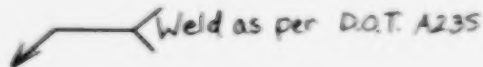
Type of electrode



See note on print

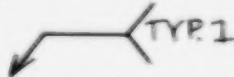


- b. Gives information as to procedures



- c. If tail is omitted, no reference information is needed.

- d. Tail can tell entire weld symbols and information.



NOTE: This type of tail would require a ledger telling all the information for this typical weldment.

8. Supplementary information

- a. Field weld (new symbol)

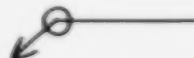


NOTE: This particular weldment is to be made at final assembly point of product. Symbol attaches at point where reference line and arrow leader join, and flag always flies over reference line.

- b. Field weld old symbol: Solid dot at joining point of reference line and arrow. Same meaning as previous symbol



- c. Weld all-around a joint



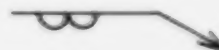
- d. Melt through the material being welded (100% penetration)



- e. Back or backing: Use back-up bar for complete fusion.

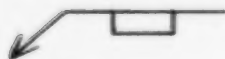


- f. Surfacing: Build up or apply some type of surface to material.

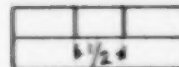
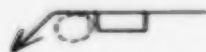


B. Plug or slot welds

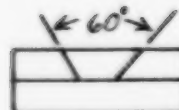
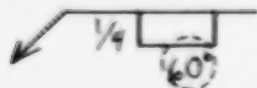
1. Size



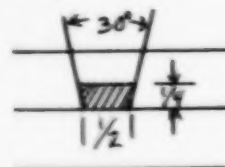
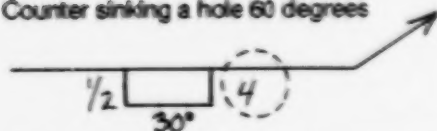
- a. Located to left of symbol



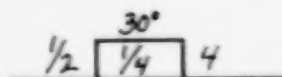
- b. Given as a whole number, fraction or decimal



2. Counter sinking a hole 60 degrees

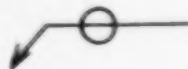


3. Pitch: a 4" center-to-center measurement from one weldment to the next

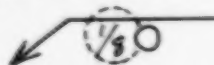


4. Amount of fill (hole from the joint)

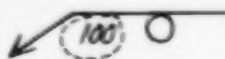
C. Spot welds



1. Size (Illustration shows 1/8" diameter.)

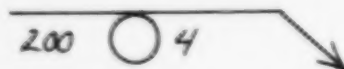


2. Strength (Illustration shows spot weld with 100 lbs. shear strength.)

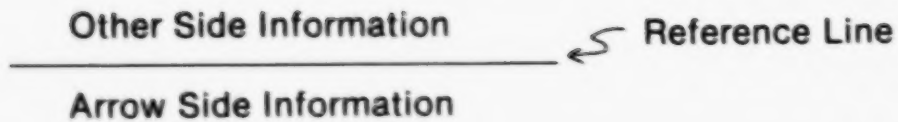


NOTE: Either size or strength can be used to establish weldment amount.

3. Pitch (Illustration shows spot welds with 200 lbs. shear strength placed 4" on center for duration of pieces joined.)

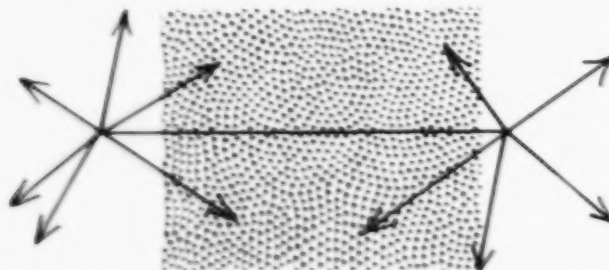


REFERENCE LINE--BOTH SIDES



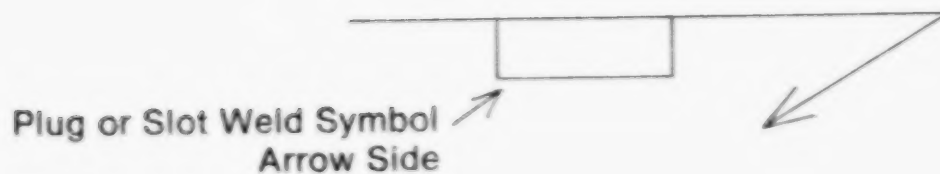
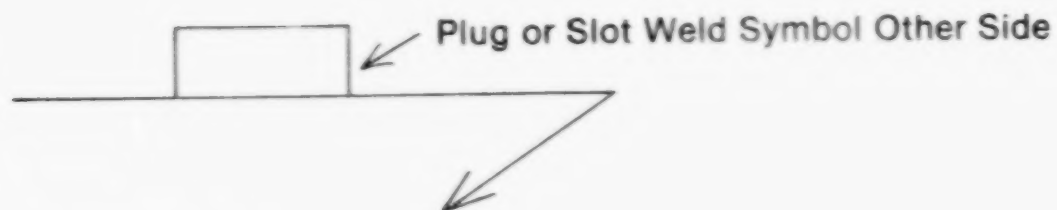
Reference line (always horizontal when read facing print)

NOTE: Arrow can join reference line from either end and point straight in any direction.



All information in shaded area will remain the same regardless of the arrow's origination end.

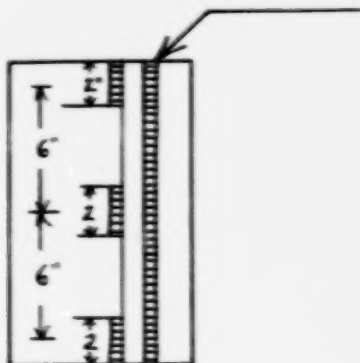
WELD SYMBOLS **(FILLET, PLUG OR SLOT WELD)**



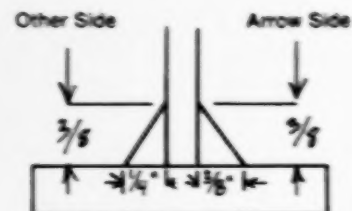
WELDMENT SIZE AND LOCATION

Write the information on given reference lines for each example.

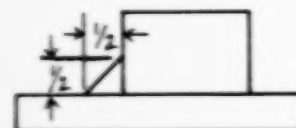
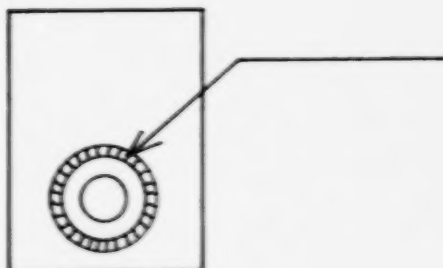
1.



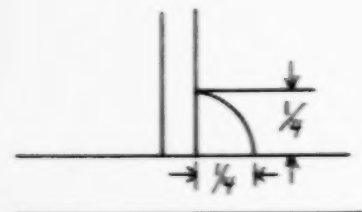
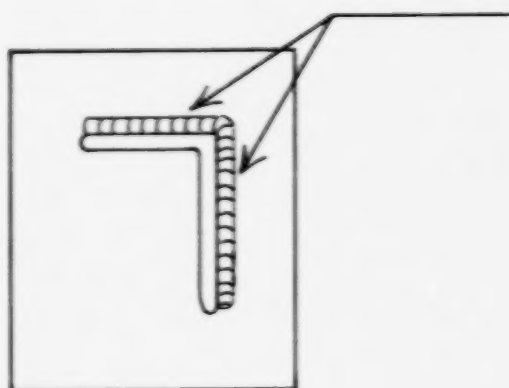
Weldment detail



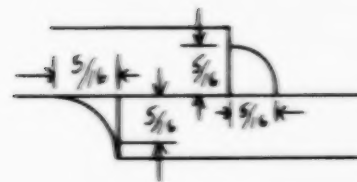
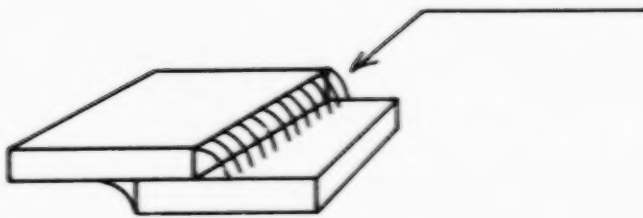
2.



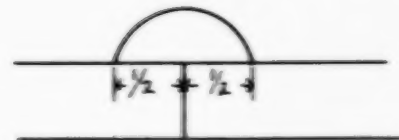
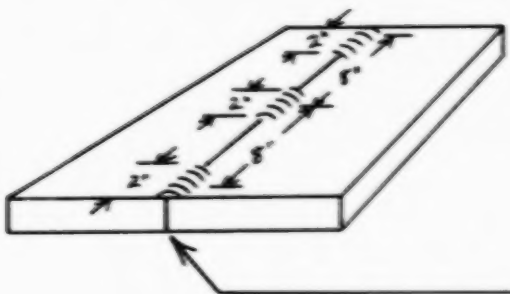
3.



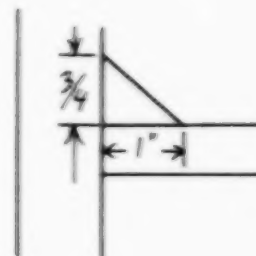
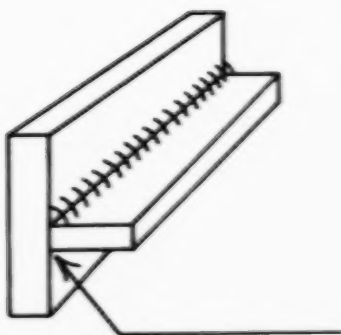
4.



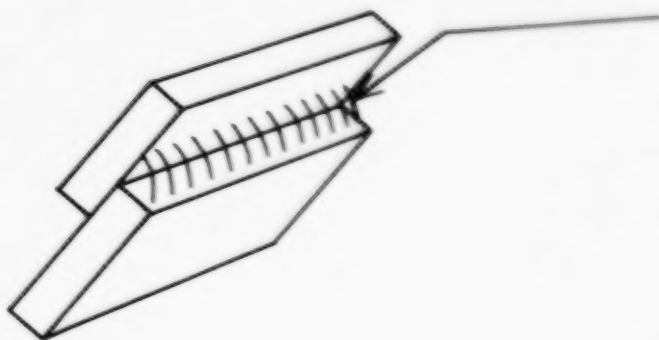
5.



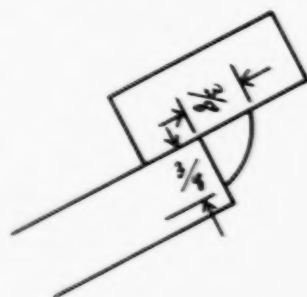
6.



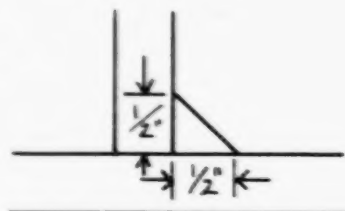
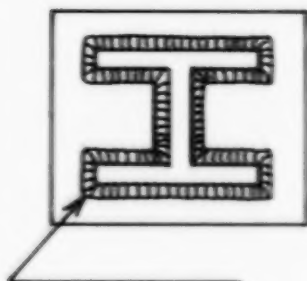
7.



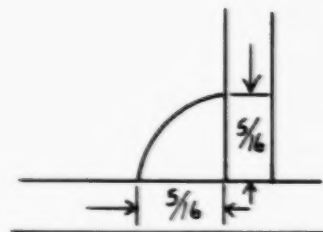
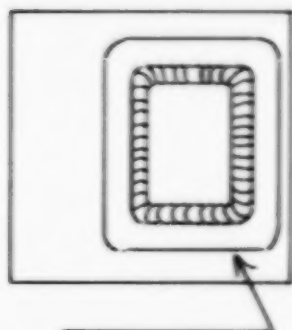
Weldment detail



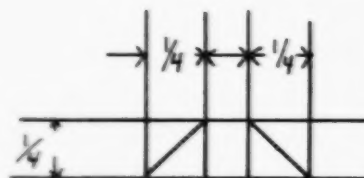
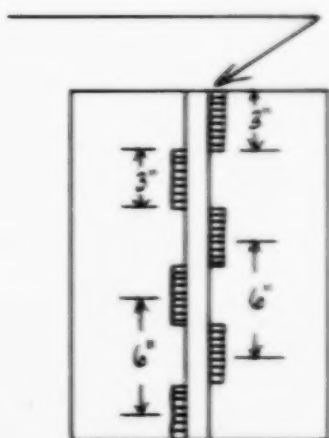
8.



9.



10.



PrR, L&F 65

TRANSLATING WELDING SYMBOLS

Directions: Make symbols for the written information given.

	Arrow side	Other side	Added ref. information
1.	a. 3/8" fillet weld b. Finished convex c. By grinding		a. Weld with GMAW
2.	a. 1/4 x 3/8" weld b. Finished flush c. By welding d. 2" weldment length e. 10" pitch	a. 3/8" fillet weld	a. Weld with SMAW b. 1/8" E7018 c. To be welded in field
3.		a. Fillet weld b. Finished concave c. By grinding	a. To be welded all around b. To be welded in field
4.	a. 5/16" fillet weld b. Welded flush c. 4" weld length d. 12" pitch e. Chain intermittent	a. 5/16" fillet weld b. Finished concave c. 4" weld length d. 12" pitch	a. Welded with GMAW b. .035 ER70S3 wire
5.	a. 1" fillet weld	a. Burn through	a. Typical
6.	a. Fillet weld b. Finish flush c. By hammering d. 8" weldment length e. 24" pitch	a. 3/8" fillet weld b. Finished concave c. By machining d. 8" weldment length e. 24" pitch	a. Welded by FCAW b. As per DOT 1-903

TRANSLATING FROM WELDING SYMBOLS

Directions: Given the following symbols, translate the information into written form (see AS 2.1).

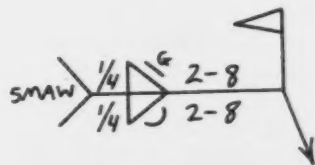
1.	Arrow side	Other side	Add. reference info.
----	------------	------------	----------------------



2.



3.



4.



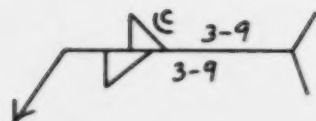
PFR, L&F 69

Arrow side

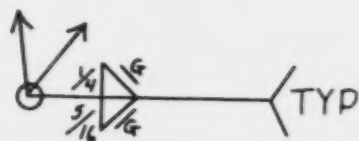
Other side

Added ref. Information

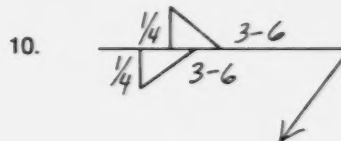
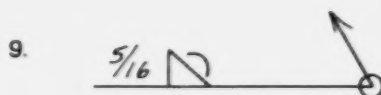
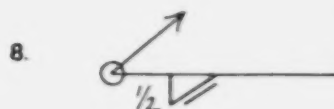
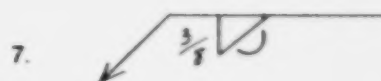
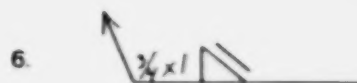
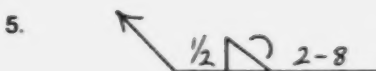
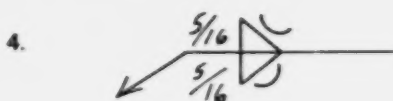
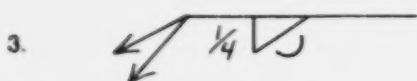
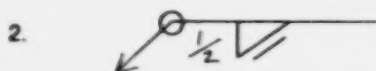
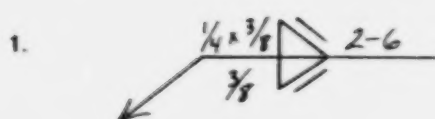
5.



6.



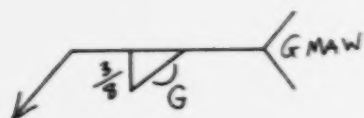
ANSWERS TO ASSIGNMENT SHEET 2.1



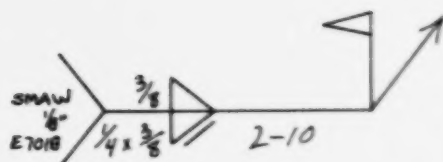
INSTRUCTOR'S NOTE: Completion of this unit's assignment sheets and unit test to instructor's satisfaction is the student's final evaluation for competency B2: Interpret welding symbols, abbreviations and joint designs.

ANSWERS TO ASSIGNMENT SHEET 2.2

1.



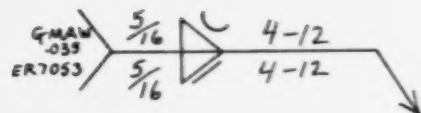
2.



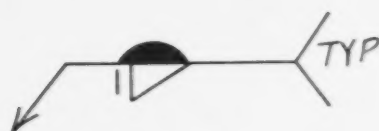
3.



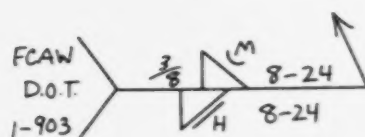
4.



5.



6.



ANSWERS TO ASSIGNMENT SHEET 2.3

Arrow side	Other side	Added ref. information
1. a. 1/4" fillet weld	a. 3/8" fillet weld	a. Weld all around
2. a. Fillet weld	a. Build up or surfacing	
3. a. 1/4" fillet weld b. Welded convex c. 2" weldment length d. 8" pitch e. Chain intermittent	a. 1/4" fillet weld b. Finished flush c. By grinding d. 2" weld length e. 8" pitch	a. Welded in field b. Use SMAW
4.	a. 3/8" fillet weld	a. Weld all around b. Use GTAW c. With E4043
5. a. Fillet weld b. 3" weld length c. 9" pitch d. Staggered intermittent	a. Fillet weld b. Finished concave c. By chipping d. 3" weldment length e. 9" pitch	
6. a. 5/16" fillet weld b. Finished flush c. By grinding	a. 1/4" fillet weld b. Finished flush c. By grinding	a. Weld all around b. Typical

MODULE: BLUEPRINT READING, LAYOUT & FIT-UP

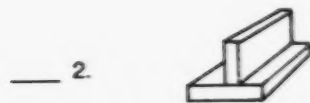
UNIT II: WELDING SYMBOLS

UNIT TEST

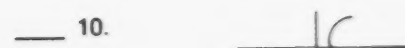
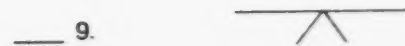
Identify the following joint types by placing the letter of the answer in the blank provided.



- a. Butt
- b. Corner
- c. Edge
- d. Lap
- e. T

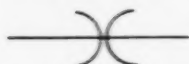


Identify the following groove symbols by placing the letter of the answer in the blank provided.



- a. Double bevel
- b. Double flare-V
- c. Flare bevel
- d. J
- e. Square
- ab. U
- ac. V bevel

— 11.



— 12.



Identify the symbol and all information pertaining to it.

	<u>Arrow side</u>	<u>Other side</u>	<u>Add. ref. info.</u>
13.	1/4" 2-6 SMAW E7018		
14.	3/16" 1/4" DGT 1-01B		
15.	1/8" 1-6		
16.	1/4" x 1/8" 2-6		
17.	3-7 3-7		

Illustrate the symbols described by the information below.

	<u>Arrow side</u>	<u>Other side</u>	<u>Add. ref. info.</u>
18.	a. 1/4" fillet weld b. Hammer flush	---	a. Weld GMAW b. Weld all around
19.	a. 3/16" fillet b. 2" weldment 10" pitch	a. 3/16" fillet b. 2" weldment 10" pitch	a. Staggered b. Intermittent

20.

- a. $3/8"$ fillet
- b. Ground concave

- a. $1/4"$ fillet
- b. $2"$ weldment
4" pitch

- a. SMAW E7018

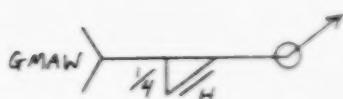
ANSWERS TO UNIT TEST (B2)

1. d
2. e
3. a
4. c
5. b
6. ab

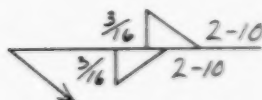
7. d
8. a
9. ac
10. c
11. b
12. e

<u>Arrow side</u>	<u>Other side</u>	<u>Add. ref. info.</u>
13. 1/4" fillet weld 2" weldment 8" pitch	---	SMAW #7018
14. 1/4" fillet weld	3/8" fillet weld	Field weld as per DOT 1.018
15. ---	Fillet weld Ground concave finish	Weld all around
16. 1/4 X 1/8 fillet weld Weld flush 2" weldment 6" pitch	---	---
17. Fillet weld 3" weldment 7" pitch Staggered intermittent	Fillet weld 3" weldment 7" pitch Staggered intermittent	---

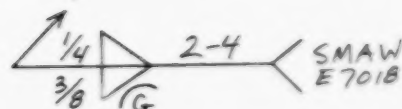
18.



19.



20.



MODULE: PRINT READING, LAYOUT & FIT-UP

UNIT III: CONSTRUCTION OF BASIC PRINTS AND STRUCTURAL SHAPES

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to sketch pictorial and three-view drawings, recognize names of and methods of measuring various structural shapes, and identify symbols for various weights of material. This knowledge will be evidenced by achieving the specified score on the unit test.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

- 1.1 Sketch a pictorial view from a three-view drawing adding all dimensions, symbols and abbreviations.
- 1.2 Sketch a three-view drawing from a pictorial view adding all dimensions, symbols and abbreviations.
- 2.1 Select the structural shape and method of measuring for various pieces of steel.
- 2.2 Differentiate between structural shapes that are measured by size only and those that are measured by size and weight.
- 2.3 Match structural steel shapes and symbols.

MODULE: PRINT READING, LAYOUT & FIT-UP

UNIT III: CONSTRUCTION OF BASIC PRINTS AND STRUCTURAL SHAPES

CONTENTS OF THIS UNIT

- A. Objective sheet
- B. References
- C. Notes to the instructor
- D. Lesson plans
 - 1. Lesson 1: CONSTRUCTING BASIC PRINTS
 - a. Information outline
 - b. Transparency masters
 - TM 1.1: Construct basic print 1
 - TM 1.2: Construct basic print 2
 - c. Assignment sheets
 - AS 1.1: Construct basic print 1
 - AS 1.2: Construct basic print 2
 - 2. Lesson 2: STRUCTURAL SHAPES, SIZES AND WEIGHTS
 - a. Information outline
 - b. Handout
 - HO 2.1: Drawing sequence of structural shapes
- E. Unit test
- F. Answers to unit test

REFERENCES

- A. Books
 - 1. Giachino, Joseph and William Weeks. Welding Skills and Practices. Chicago: American Technical Publishers, Inc., 1976.
 - 2. Horwitz, Henry. Welding Principles and Practices. Boston: Houghton Mifflin Company, 1979.

3. Sacks, J. Raymond. Welding Principles and Practices. Peoria, Ill.: Charles A. Bennett Co., Inc., 1976.

B. Curriculum guide

1. Fortney, Clarence, and Mike Gregory. Blueprint Reading and Layout for Welding. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. This lesson is an exercise for students to complete. By now, students should be able to read prints and understand all abbreviations and symbols. This lesson brings together and uses the information in the previous two units.
2. Give students a three-view drawing. Have them produce a pictorial sketch including all dimensions, symbols and abbreviations.
3. Give students a pictorial drawing. Have them produce a three-view drawing, adding all dimensions, symbols and abbreviations.
4. Use the transparencies in this lesson to help students understand their assignments.

B. Suggested student activities

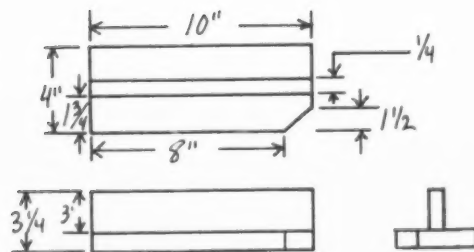
1. Using manufacturer specification charts or books, have students research proper weights and sizes of various structural shapes.

C. Suggested supplemental materials

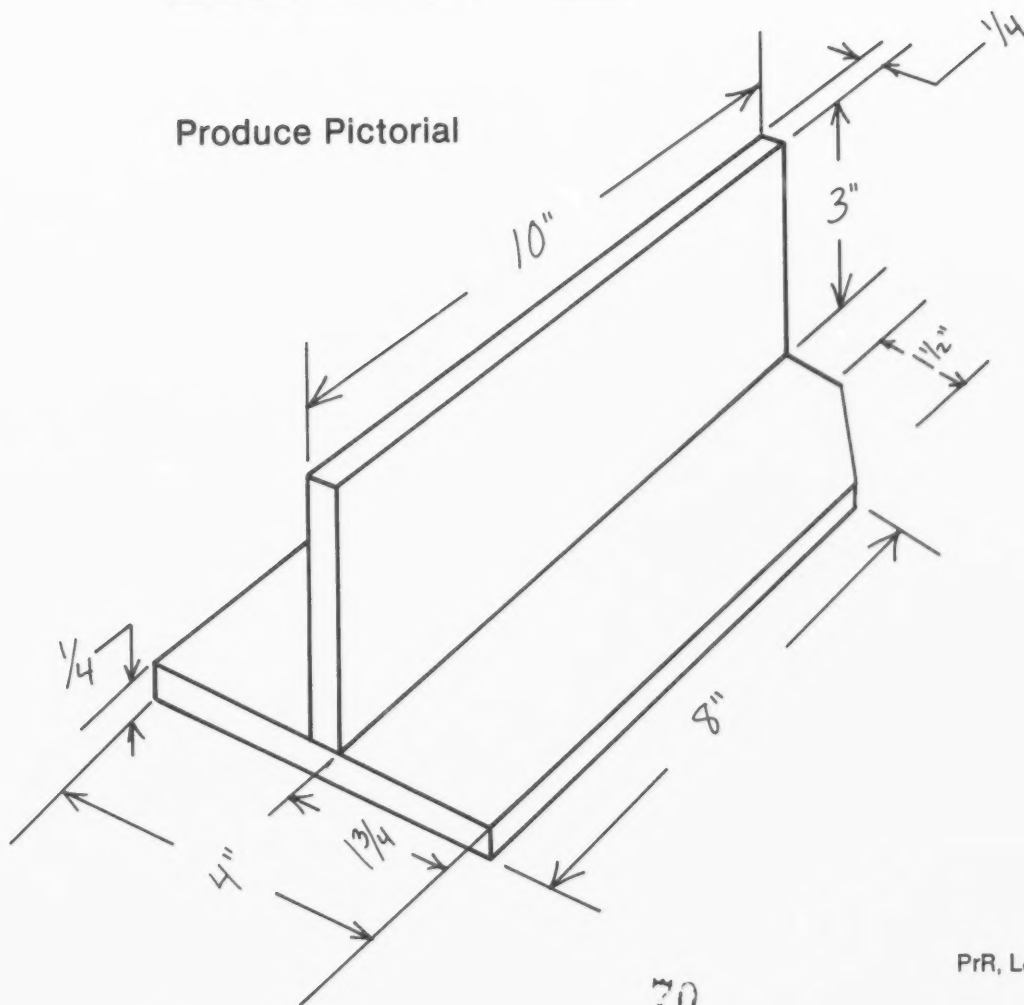
1. Welding Supplementary Units. Columbia: Instructional Materials Laboratory, University of Missouri-Columbia, 1988.

CONSTRUCT BASIC PRINT 1

Given: Three-View

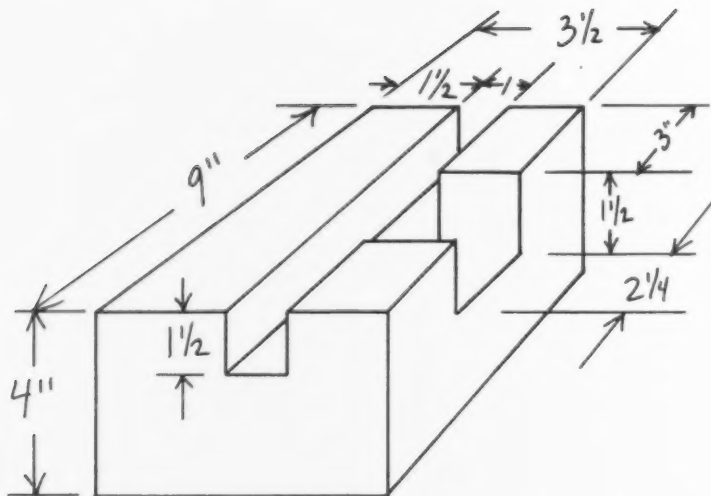


Produce Pictorial

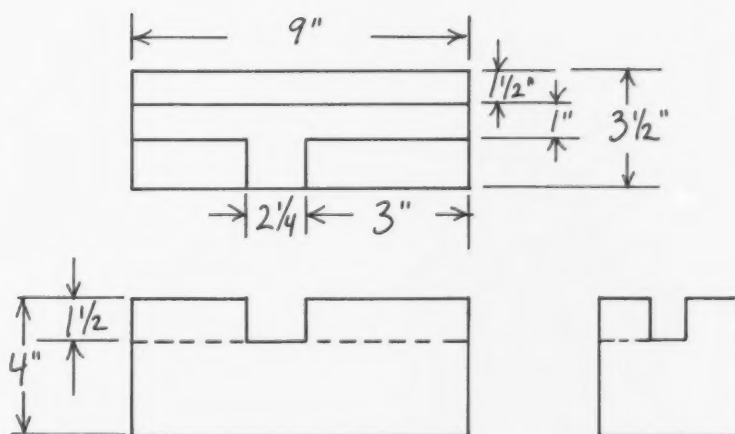


CONSTRUCT BASIC PRINT 2

Given Pictorial

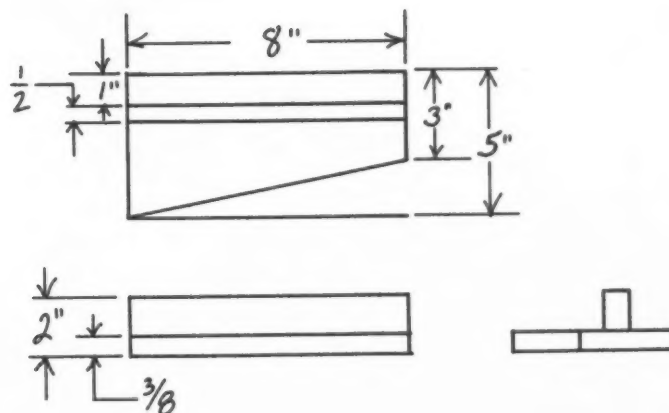


Produce Three-View



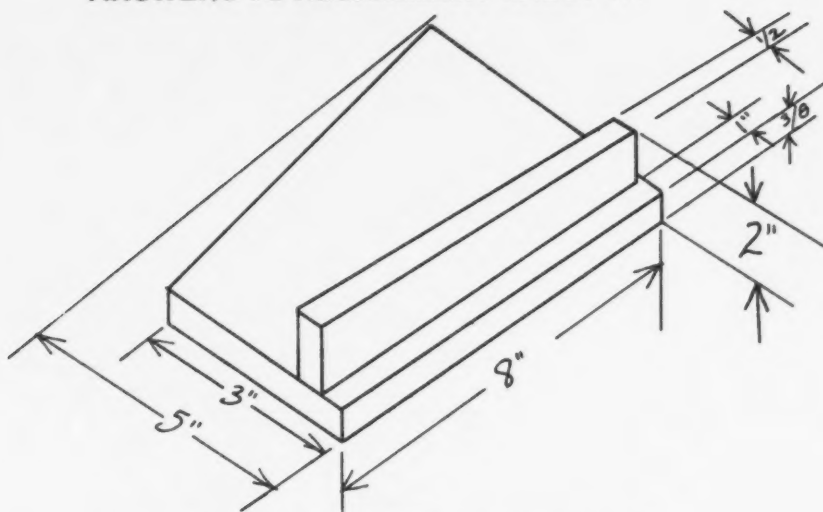
CONSTRUCT BASIC PRINT 1

From this three-view drawing, sketch a pictorial drawing that includes all dimensions, symbols and abbreviations.

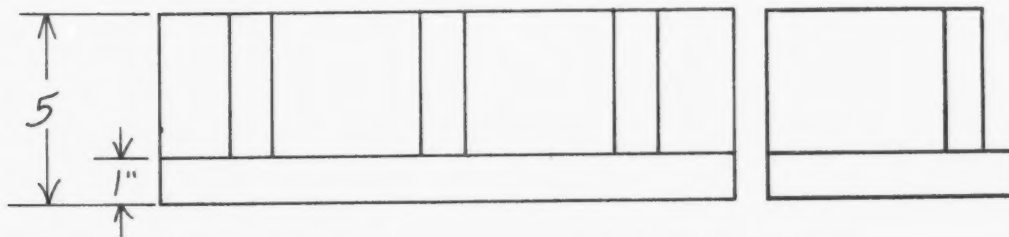
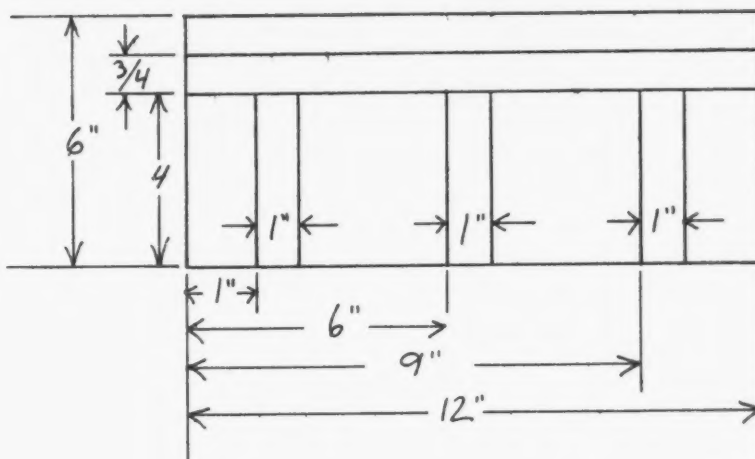


NOTE: Completion of Assignment Sheets 1.1 and 1.2 to instructor's satisfaction is the student's final evaluation for competencies B3 and B4.

ANSWERS TO ASSIGNMENT SHEET 1.1



ANSWERS TO ASSIGNMENT SHEET 1.2



MODULE: PRINT READING, LAYOUT & FIT-UP

UNIT III: CONSTRUCTION OF BASIC PRINTS AND STRUCTURAL SHAPES

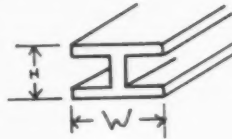
LESSON 2: STRUCTURAL SHAPES, SIZES AND WEIGHTS

I. Types of structural shapes and method of measuring

NOTE: Refer to manufacturer specifications for proper weights and measurements of various structural shapes.

A. Beams

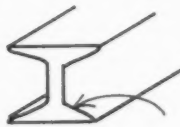
1. Structural H or (WF) beams



height X width of beam

NOTE: Although "H beam" is a term still commonly used, the industry standard is to indicate a beam with wide flanges that has parallel flange surfaces.

2. Structural I or S beam

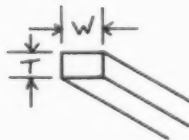


height X width of beam

NOTE: Although "I beam" is a term still commonly used, the industry standard is "S beam" to indicate a standard beam with the flanges having a definite slope.

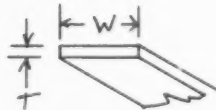
B. Flat shapes

1. Square bars



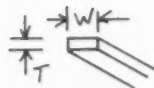
thickness X width

2. Hot- and cold-rolled flats



thickness X width

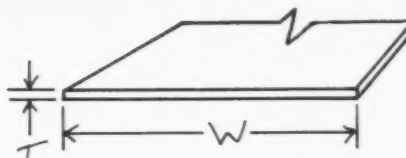
3. Hot-rolled strips



thickness X width

4. Hot- and cold-rolled sheets

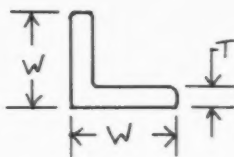
thickness X width



C. Angular shapes

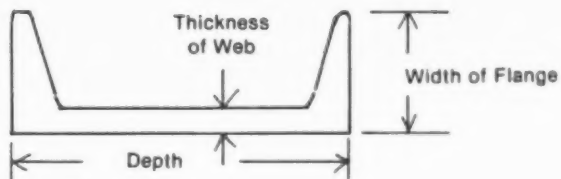
1. Bar and structural angles

width X width X thickness



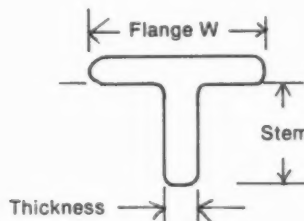
2. Bar size channel

depth X width of flange X thickness of web



3. Structural T

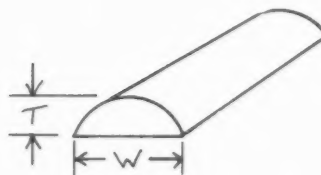
width X height X thickness



D. Round and semi-round shapes

1. Hot-rolled half oval

thickness X width



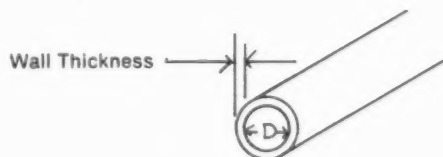
2. Hot- and cold-rolled rounds

diameter



3. Pipe

diameter X wall thickness



II. Weights of materials and symbols

A. Size shapes only

1. Square bar 
2. Hot- and cold-rolled flats and strips (no symbol)
3. Sheets and plates  or  or PL
4. Angles 
5. Half ovals 
6. Rounds  or 
7. Pipe 

B. Sized by weight

1. Structural H or W^F Beam 
2. Structural I or S beams 
3. Bar and structural T 
4. Bar size channel 

NOTE: Usually beams, Ts and channels are noted by height and weight. For example, an 8" X 8" WF beam is noted by 8 WF 8.5, meaning the beam weight is 8.5 lb./ft. A beam with a higher weight, i.e. 12.5 lb./ft, would have thicker flanges and web.

DRAWING SEQUENCE FOR STRUCTURAL SHAPES

Shape	Symbol	Written Sequence	Drawing Sequence
Square Bar	■	Size, Symbol, Length	$\frac{1}{2}$ ■ 6' - 4
Round Bar	●	Size, Symbol, Length	$\frac{1}{2}$ ⌀ 8' - 6
Plate	—	Symbol, Width, Thickness, Length	$\overline{P}$ 6 × $\frac{1}{4}$ × 9
Equal Leg Angle	└	Symbol, Leg, Leg, Thickness, Length	◁ 2 × 2 × $\frac{1}{8}$ × 12' - 0
Unequal Leg Angle	└	Symbol, Long Leg, Short Leg, Thickness, Length	◁ 2 × $1\frac{1}{2}$ × $\frac{1}{4}$ × 9' - 0
Channel	C	Height, Symbol, Weight, Length	6 C 10.5 × 15' - 4
Standard Beam	I	Height, Symbol, Weight, Length	12 I 31.8 × 10' - 2
Wide Flange Beam	I	Height, Symbol, Weight, Length	8 WF 8.5 × 30' - 6
Structural T	T	Symbol, Height, Weight, Length	ST4 WF 8.5 × 30' - 6
Tee	T	Symbol, Flange, Stem, Weight, Length	T5 × 3 × 11.5 × 11' - 0
Pipe	○	Nominal Diameter, Symbol, Thickness	24 ⌀ .500

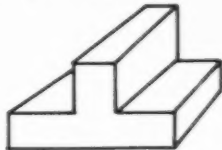
MODULE: PRINT READING, LAYOUT & FIT-UP

UNIT III: CONSTRUCTION OF BASIC PRINTS AND STRUCTURAL SHAPES

UNIT TEST

Select the best answer from the choices listed.

- ___ 1. Identify the type of drawing below.



- a. Pictorial
- b. Orthographic
- c. Cabinet
- d. Three-view

- ___ 2. Which views are shown by three-view drawings?

- a. Top, bottom, side
- b. Bottom, side, top
- c. Side, top, side
- d. Top, side, end

- ___ 3. Pictorial drawings give the idea of a ____ view.

- a. Three
- b. End
- c. Three-dimensional
- d. Bird's eye

- ___ 4. Where are pictorial drawings found on a three-view print?

- a. The upper right-hand corner
- b. The lower right-hand corner
- c. The center
- d. Any position

- ___ 5. Dimensioning in pictorial drawings is given in ____.

- a. Decimals
- b. Metric
- c. Fractions
- d. Various dimensions

- ___ 6. The most detailed view of a print is found on the ____ sketch.

- a. Three-view
- b. Pictorial
- c. Cabinet
- d. Sectional

___ 7. The most common types of prints used are ___.

- a. Cabinet and three-view
- b. Three-view and pictorial
- c. Sectional and three-view
- d. Sectional

Match the structural shape to its method of measurement by placing the appropriate letter in the blank provided.

- | | |
|---|-------------------------------------|
| ___ 8. Square bar | a. Size and weight |
| ___ 9. Hot- and cold-rolled flats | b. Size only |
| ___ 10. Structural H or WF beams | |
| ___ 11. Hot-rolled strips | |
| ___ 12. Hot- and cold-rolled sheets or plates | |
| ___ 13. Bar and structural angles | |
| ___ 14. Bar and structural Ts | |
| ___ 15. Structural I or S beams | |
| ___ 16. Bar size channel | ___ 18. Hot- and cold-rolled rounds |
| ___ 17. Hot-rolled half ovals | ___ 19. Pipe |

Match the structural shape symbol with its descriptor.

- | | |
|---------------------------|---|
| ___ 20. Channel | a.  |
| ___ 21. Equal leg angle | b.  |
| ___ 22. Pipe | c.  |
| ___ 23. Plate | d.  |
| ___ 24. Round bar | e.  |
| ___ 25. Square bar | ab.  |
| ___ 26. Standard beam | ac.  |
| ___ 27. Structural T | ad.  |
| ___ 28. T | ae.  |
| ___ 29. Wide flange beam | bc.  |
| ___ 30. Unequal leg angle | bd.  |

NOTE: Successful completion of this unit test to specified score is the student's final evaluation for competency B5: Interpret structural shapes, sizes and weights.

ANSWERS TO UNIT TEST (B5)

1. a
2. d
3. c
4. d
5. d
6. a
7. b
8. b
9. b
10. a
11. b
12. b
13. b
14. a
15. a

16. a
17. b
18. b
19. b
20. ab
21. d
22. bd
23. c
24. b
25. a
26. ac
27. ae
28. bc
29. ad
30. e

MODULE: PRINT READING, LAYOUT & FIT-UP

UNIT IV: GUIDELINES, TRUE LENGTH AND MATERIAL THICKNESS

UNIT OBJECTIVES

Upon completion of this unit, the student should learn guidelines for layout procedures, bend allowances, basic tools and how material thickness affects layout. The student should be able to lay out a square box, determine true lengths, lay out a square cone and determine actual size of a finished object. This knowledge will be evidenced by achieving the specified score on the unit test and job sheets.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

- 1.1 Distinguish between true and false layout guidelines.
- 1.2 Select a safe rule of thumb for bend allowances.
- 1.3 List basic tools required for layout.
- 1.4 Use parallel development to lay out a square box.
- 2.1 Lay out a square cone.
- 3.1 Determine actual part sizes from a drawing of a finished object.

MODULE: PRINT READING, LAYOUT & FIT-UP

UNIT IV: GUIDELINES, TRUE LENGTH AND MATERIAL THICKNESS

CONTENTS OF THIS UNIT

- A. Objective sheet
- B. References
- C. Notes to the instructor
- D. Lesson plans
 - 1. Lesson 1: LAYOUT GUIDELINES
 - a. Information outline
 - b. Transparency masters
 - TM 1.1: Parallel development
 - TM 1.2: Independent development
 - c. Job sheet
 - JS 1.1: Square box layout
 - 2. Lesson 2: TRUE LENGTH
 - a. Information outline
 - b. Transparency master
 - TM 2.1: Blueprint views and true lengths
 - c. Handout
 - HO 2.1: Layout of a square cone
 - d. Job sheet
 - JS 2.1: Lay out a square cone
 - 3. Lesson 3: MATERIAL THICKNESS
 - a. Information outline
 - b. Assignment sheet
 - AS 3.1: Finding correct part sizes
- E. Unit test
- F. Answers to unit test

REFERENCES

A. Books

1. Franklin, Thomas W. Pipe Fitters Handbook. Encino, Calif.: Glencoe Publ. Co., 1984.

B. Curriculum guide

1. Fortney, Clarence, and Mike Gregory. Blueprint Reading and Layout for Welding. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Job sheets

- a. The job sheet in Lesson 1 can be done on steel plate with no damage to the plates. If you prefer that students cut plates and finish the project, instruct them accordingly. No information has been given for material thickness and bend allowances. Adjust measurements for plate thickness and lengths.
- b. JS 2.1 can be completed on steel plate, aluminum, cardboard or any other material that is readily available. Note that it is advisable to make changes in the dimensions of layout prints so each student's layout will be slightly different in each case. Each student must then think independently to complete the job sheet. HO 2.1 is provided for use with this job sheet.

B. Suggested student activities

1. Have students tap holes, thread rods or other projects involving layout and measurement. Students can use different kinds of measuring tools on samples that have been made and saved from previous years. Make sure micrometer checking is made without weather expansion or contraction.
2. Students can layout and construct a small box to be welded and tested for leaks. The instructor should set limits such as metal size, degrees of bevel and thickness.
3. Students can layout simple projects that can be taken home later--boot scrapers, candle holders, stools, etc.

C. Suggested supplemental materials

1. Welding Supplementary Units. Columbia: Instructional Materials Laboratory, University of Missouri-Columbia, 1988.
2. Videotapes from The Media Center, State Fair Community College, Sedalia, Mo.
 - a. Layout, Part I: Blueprints (W-88-210)
 - b. Layout, Part II: Tool Selection and Use (W-88-211)

MODULE: PRINT READING, LAYOUT & FIT-UP

UNIT IV: GUIDELINES, TRUE LENGTH AND MATERIAL THICKNESS

LESSON 1: GUIDELINES

I. Guidelines

- A. Place metal or material on a working surface that provides convenient access for measuring from as many sides as possible.
- B. When using plate materials, always check the plate for squareness; if necessary, square uneven corners by shearing, grinding, etc.
- C. If the job does not require all corners to be square, find and mark a square corner to use as a working point.

NOTE: Although there are some exceptions, a good rule of thumb for all layout is to start from a square corner.

- D. When using templates or patterns directly on metal, take best advantage of the metal to minimize waste.
- E. When using templates or patterns on patterned materials (such as tread plate), reverse the left or right template to avoid duplicating a part.
- F. Minimum waste is an important objective of all layout activity.
- G. Always double check every measurement to make sure it agrees with the drawing from which it is taken.
- H. Cut out major components first so that cutting allowances for smaller parts will not have to be established and added.
- I. Grind major components before continuing with the layout. Grind them only to the degree required for cleanup or they may become out of tolerance.
- J. Always double-check every measurement on any part that required grinding. In the event that the part has been ground out of tolerance, a matching piece can be laid out larger to compensate for the difference and save material.
- K. Lay out, cut and clean up smaller components. Check all measurements as required.
- L. Measurements are generally recorded from smallest to largest ($2" \times 3 \frac{1}{2}" \times 4 \frac{1}{4}"$).

II. Bend allowances

- A. When specifications call for bending a plate or pipe, add an extra amount of metal for the bend allowance.
- B. A safe rule of thumb is to add to the metal's length an amount equal to the thickness of the metal for each bend.

NOTE: This rule of thumb will usually exceed the bend allowance, but it's better to have too much than too little. For critical fit up, a bend allowance chart for the specific metal plate or pipe should be used.

III. Basic tools required

A. Steel rulers for measuring and for using as a straightedge

NOTE: Rulers come in 12", 24" and 36" lengths. It is a good idea to have a rule of each size handy when starting a layout project.

B. Retractable steel tape rule for measuring long lengths and for cross measuring

C. Combination framing and try square for finding, marking and checking angles

D. Bevel or swinging blade protractor for finding and marking critical angles quickly

E. Chalk line for snapping long, straight lines

F. Metal scribe

G. Bevel square for laying out angles other than right angles

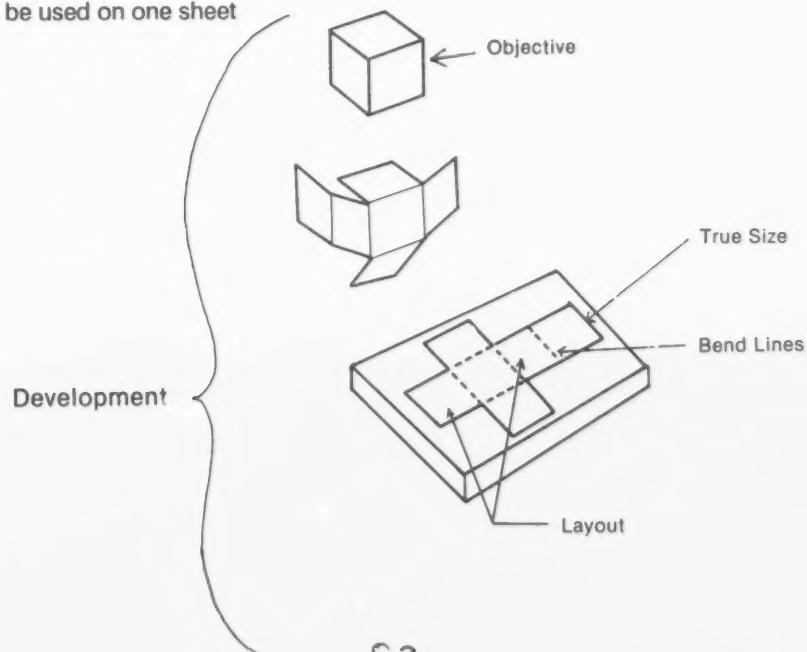
H. Center punch for marking permanently established work points or center line

I. Wing dividers or radius markers to make arcs, circles, etc.

IV. Methods of layout (TM 1.1, 1.2)

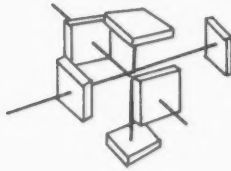
A. Parallel development

1. Used when the item is to be made from as few individual (separate) pieces as possible
2. Can be used on one sheet

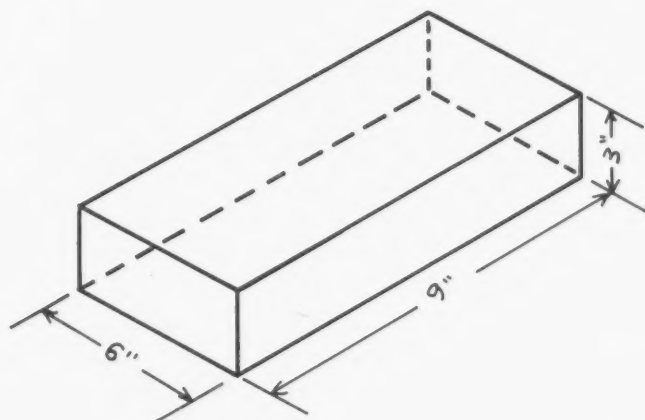


B. Independent development

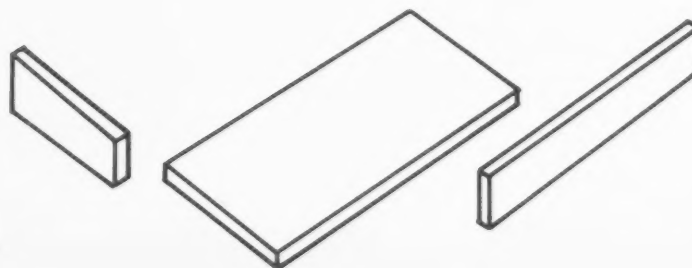
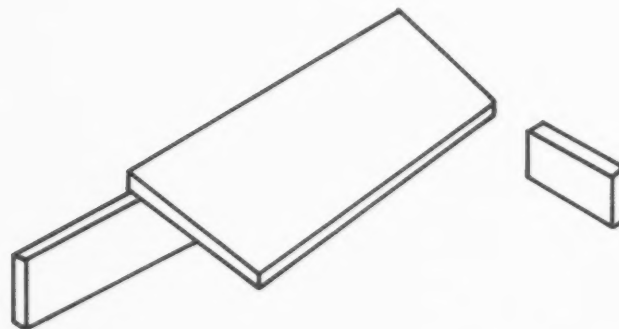
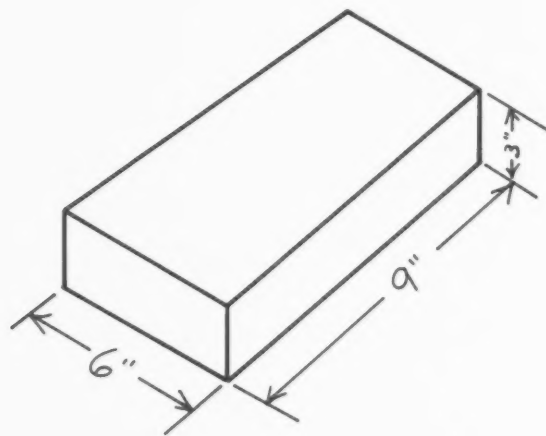
1. Item is made from several independent pieces.
2. Used when metal bending can't be done because of shape, metal thickness, etc.



PARALLEL DEVELOPMENT



INDEPENDENT DEVELOPMENT



SQUARE BOX LAYOUT

Equipment:

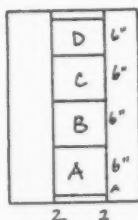
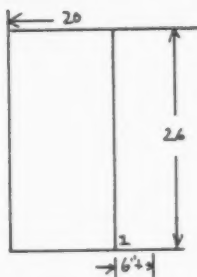
Framing square

Print

Soapstone or scribe

Metal plate 20" x 26" or larger

Procedure:



1. Establish a side from which to start square line.
2. From the corner of one side of the metal, move more than 6" toward the center and mark a perpendicular line at least 26" long. Mark point 1.
3. From point 1, move 6" toward the left and mark a line parallel to point 1.
4. From bottom of plate (where points 1 and 2 are established), move up line 1/2" and mark point A. From A, mark four 6" sections and square or perpendicular lines connecting lines 1 and 2.
5. From this point, the four sides of the box are made; only the top and bottom are left. These can be added from any of the 6" square boxes. They can be on opposing sides of any of the boxes or they can be added to the right or left of A, B, C or D. The top (T) must be on an opposite side of the squares.
6. Choose one of the squares marked X for the bottom and one marked T for top.
7. Ask instructor to check your work.

Evaluation

3 2 1 N

— — — —

— — — —

— — — —

— — — —

— — — —

— — — —

— — — —

8. Clean area, return tools and put all materials in appropriate place.

— — — —

9. Proceed to next job sheet as instructor directs.

— — — —

Average of above evaluation*

— — — —

*This average is the student's partial evaluation for competency D1: Make layout of material for plate, structural and pipe fabrication.

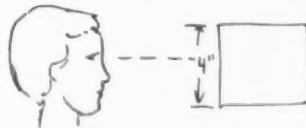
MODULE: PRINT READING, LAYOUT & FIT-UP

UNIT IV: GUIDELINES, TRUE LENGTH AND MATERIAL THICKNESS

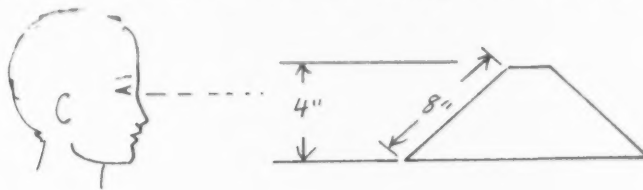
LESSON 2: TRUE LENGTH

I. Views of a print

- A. A print will give three-dimensional information on height, length, width, etc., but without close observation, true lengths can be missed.
- B. On vertical surfaces, the print runs true to the eye.



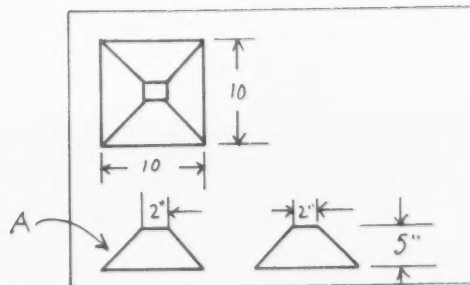
- C. On non-vertical or slanting surfaces, one must pay particular attention to detail.



NOTE: The true length is 8", but as the welder views this object, it appears to have a 4" vertical height.

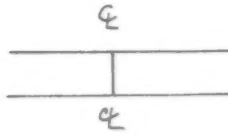
II. True lengths

- A. To find true lengths, a welder must look carefully at the print.
- B. The print that follows does not have a dimension for the true length of the line marked A.

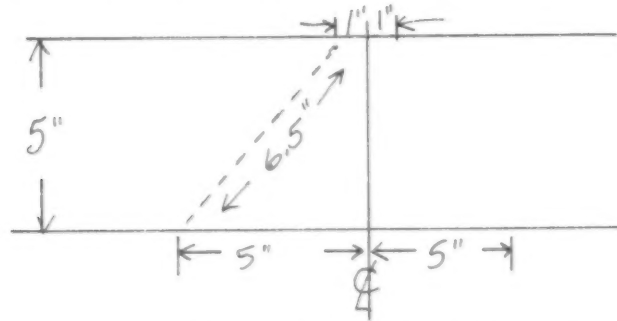


C. The welder must calculate the true length of side A. Follow the information below.

1. The print shows a vertical rise of 5", so lay out two parallel lines 5" apart.
2. In the middle of the bottom line, draw a line perpendicular and label it center line.

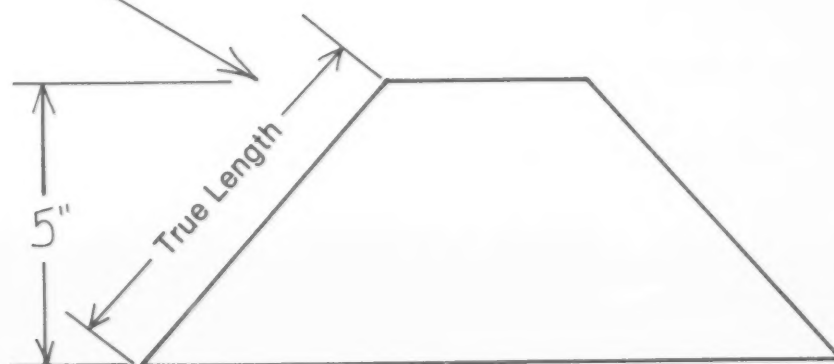
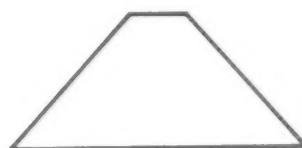
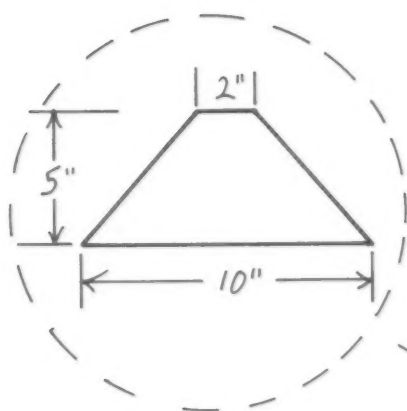
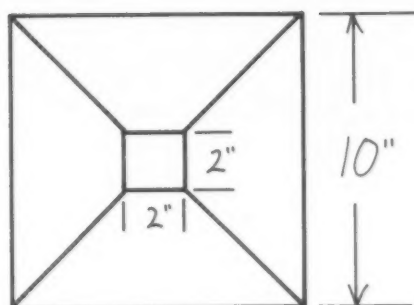


3. The print shows the base of the square cone to be 10", so divide the cone in half at the center line so 5" are on each side of the line. Also note the top of the cone is 2" square. Divide this in half.
4. Using a steel rule or measuring device, plot the above points on the parallel lines.

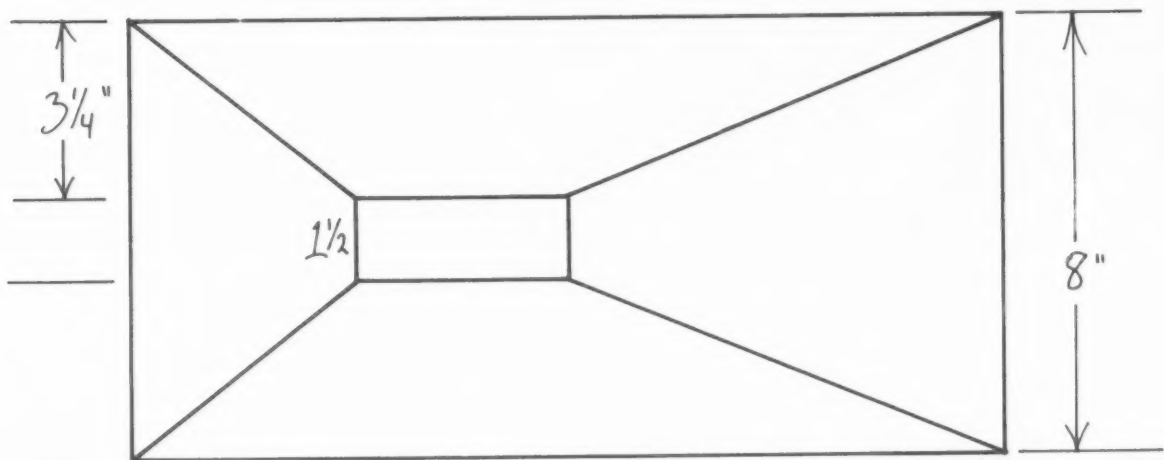
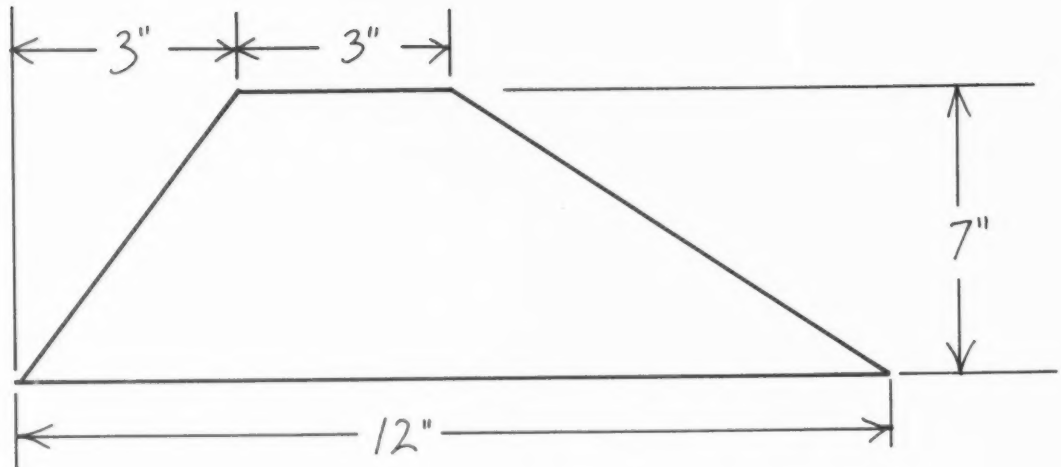


5. Now connect the points (5" and 1") on the left side of the center line and measure them for true length.
6. The true length is 6.5".
7. To lay out this piece on parallel lines spaced 6.5" apart, mark all measurements as listed before. Connect both points on left side of center line and then both points on right side of center line.
8. Now the true length and size of one of the funnel's sides is laid out.
9. Repeat steps to lay out the remaining sides of the funnel.

BLUEPRINT VIEWS AND TRUE LENGTHS



LAYOUT OF A SQUARE CONE



LAY OUT A SQUARE CONE

Equipment:

Material (as instructor directs)
 Blueprint (use HO 2.1)
 Marking device
 Steel rules (as needed)

Procedure:

Evaluation
 3 2 1 N

1.	The print shows a vertical rise or height of 5", so lay out two parallel lines 5" apart.	—	—	—	—
2.	In the middle of the bottom line, draw a perpendicular line to the top line and label it center line.	—	—	—	—
3.	The print shows the base of the square cone to be 10", so divide the cone in half at the center line so that 5" remains on each side of the line. Note that the top of the cone is 2" square. Divide this in half.	—	—	—	—
4.	Using a steel rule or measuring device, plot the above points on the parallel lines.	—	—	—	—
5.	Connect the points (5" and 1") on the left side of the center line and measure them for true length (should be 6.5").	—	—	—	—
6.	To lay out this piece on parallel lines spaced 6.5" apart, mark all measurements as listed before. Connect points on the left side of center and then points on the right side.	—	—	—	—
7.	Now the true length and size of one of the funnel's sides are laid out.	—	—	—	—
8.	Follow all steps previously mentioned to lay out the remaining sides of the funnel.	—	—	—	—
9.	Ask instructor to check your work.	—	—	—	—
10.	Put away all tools and equipment as instructed or advance to the next job sheet.	—	—	—	—
Average of above evaluation*		—	—	—	—

*This average is the student's partial evaluation for competency D1: Make layout of material for plate, structural and pipe fabrication.

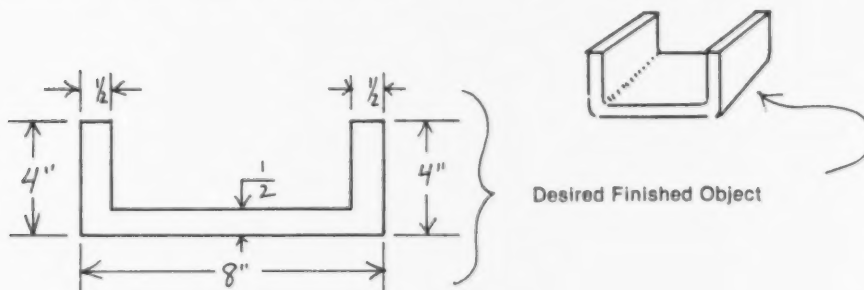
MODULE: PRINT READING, LAYOUT & FIT-UP
UNIT IV: GUIDELINES, TRUE LENGTH AND MATERIAL THICKNESS
LESSON 3: MATERIAL THICKNESS

I. Tolerances

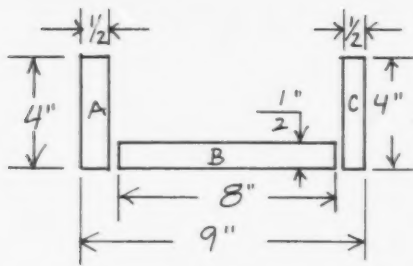
- A. In the title block of the blueprint there is a space called "tolerances." This block will indicate to a welder if the object can be larger or smaller than specified in print.
- B. Tolerances can be given in two forms.
1. Fractional form ($1/16$, $1/8$, etc.)
 2. Decimal form (.062, .125, etc.)
- C. Tolerances can be limited.
1. Unilateral (different only in one direction)
 - a. Can be longer than but no shorter
 - b. Can be shorter than but no longer
 2. Bilateral (Piece can be longer or shorter by a certain amount, as specified by tolerance.)
- D. Method of showing tolerance
1. Bilateral
 - a. symbol means plus (+) or minus (-)
 - b. Examples: $1/8"$ or .125
 2. Unilateral ($+1/8"$ or $+.125$)

II. Adjustments for material thickness

- A. Depending on joint type and tolerances, a welder may have to subtract or shorten the dimensions from a print to have the object in the print made to tolerance.



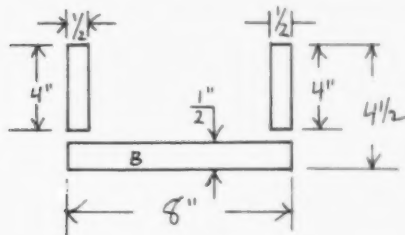
1. If welder cuts all the plates to the exact measurement of print, oversizing of the object will occur.



$$1/2" + 8" + 1/2" = 9"$$

$A + B + C = 9"$ or a finished size of 4" high by 9" long

2. This may (depending on print's tolerance) render the finished object useless because it is 1" longer than specified.
3. If pieces A and C are moved to sit on top of plate B, the dimensions for a finished object will still not be correct.



$$1/2" + 4" = 4 1/2"$$

$B + A = 4 1/2"$ (1/2" over height tolerance)

B. Depending on joint design, there are ways to correct oversizing.

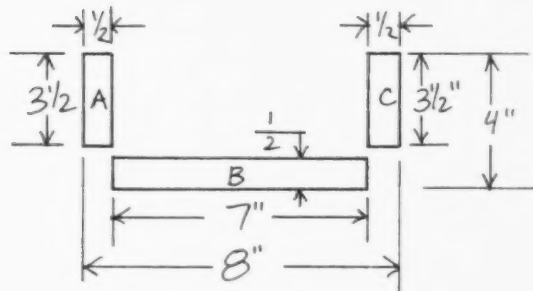
1. Outside corner joint: All three pieces are to be undersized.

a. Parts A and C must be shortened 1/2".

b. Part B must be shortened 1".

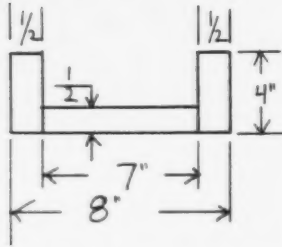
Horizontal length $1/2" + 7" + 1/2" = 8"$ ($A + B + C = 8"$)

Vertical height $3 1/2" + 1/2" = 4"$ ($A + B = 4"$)



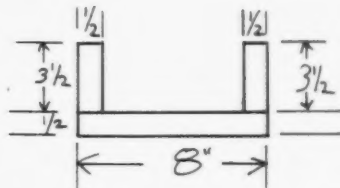
2. Square corner: One or two (B or A and C) must be shortened to complete the finished object to tolerance.

- a. Shortening one piece (B)



Part B is shortened 1" to allow for the thickness of parts A and C to bring total length to 8".

- b. Shortening two pieces (A and C)

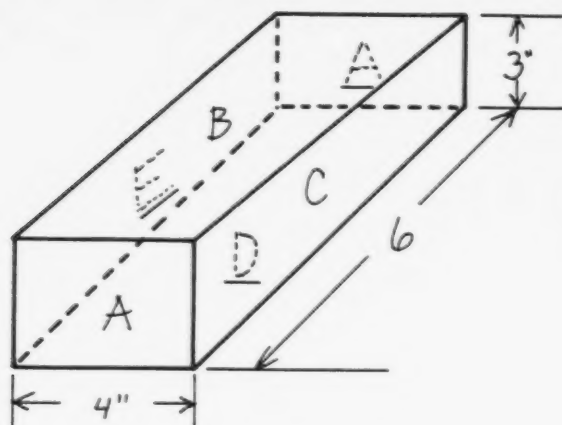


- C. Layout is critical. Pay particular attention to detail on blueprints to avoid costly errors!
- D. This applies not only to length but also to width.

NOTE: The above information deals with 1/2" thick material. Special care should be taken to compensate if metal thickness is 1/8", 1/4", 3/4", 5/16", 1", etc.

FINDING CORRECT PART SIZES

Given the following finished object, find the actual size of each piece in inches for outside corner joints.



NOTE: Parts A, D and E are not visible in the drawing, but they are assumed for this exercise. All corners are square.

If all pieces are $1/4$ " thick:

1. A =
2. A =
3. B =
4. C =
5. D =
6. E =

If all pieces are $3/8$ " thick:

7. A =
8. A =
9. B =
10. C =
11. D =
12. E =

Parts A and A $1/2$ " thick;

parts B, C, D and E $1/4$ " thick:

13. A =
14. A =
15. B =
16. C =
17. D =
18. E =

NOTE: Completion of this assignment sheet to a specified score is the student's partial evaluation for competency D1: Make layout of material for plate, structural and pipe fabrication.

ANSWERS TO ASSIGNMENT SHEET 3.1

- | | |
|---------------------------------------|--|
| 1. $3\frac{1}{2} \times 3\frac{1}{2}$ | 10. $2\frac{1}{4} \times 5\frac{1}{4}$ |
| 2. $3\frac{1}{2} \times 3\frac{1}{2}$ | 11. $3\frac{1}{4} \times 5\frac{1}{4}$ |
| 3. $3\frac{1}{2} \times 5\frac{1}{2}$ | 12. $2\frac{1}{2} \times 5\frac{1}{2}$ |
| 4. $2\frac{1}{2} \times 5\frac{1}{2}$ | 13. $3\frac{1}{2} \times 3\frac{1}{2}$ |
| 5. $3\frac{1}{2} \times 5\frac{1}{2}$ | 14. $3\frac{1}{2} \times 3\frac{1}{2}$ |
| 6. $2\frac{1}{2} \times 5\frac{1}{2}$ | 15. $3\frac{1}{2} \times 5$ |
| 7. $3\frac{1}{4} \times 3\frac{1}{4}$ | 16. $2\frac{1}{2} \times 5$ |
| 8. $3\frac{1}{4} \times 3\frac{1}{4}$ | 17. $3\frac{1}{2} \times 5$ |
| 9. $3\frac{1}{4} \times 5\frac{1}{4}$ | 18. $2\frac{1}{2} \times 5$ |

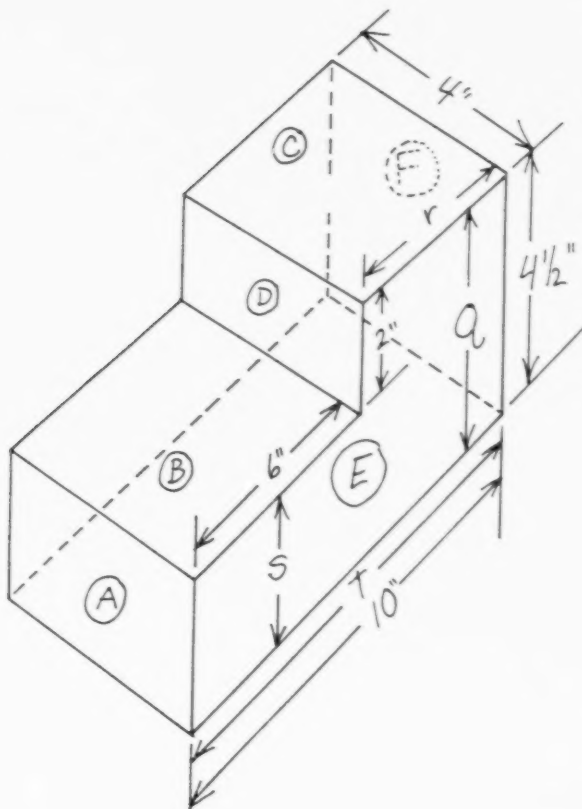
MODULE: PRINT READING, LAYOUT & FIT-UP

UNIT IV: GUIDELINES, TRUE LENGTH AND MATERIAL THICKNESS

UNIT TEST

Given the following finished object, find the actual size of each piece for outside corner joint. Choose the correct answer from those given.

NOTE: Part F is hidden from sight. Part E has letters Q, R, S and T to help define the actual size of piece as thicknesses change. Object is a complete, sealed box.



All parts 1/4" thick

1. A = __

- (a) $3 \frac{1}{4}" \times 1 \frac{3}{4}"$
(d) $3 \frac{1}{2}" \times 2 \frac{1}{4}"$

(b) $3 \frac{1}{2}" \times 1 \frac{3}{4}"$

(c) $3 \frac{1}{2}" \times 2"$

2. B = __

- (a) $3 \frac{1}{4}" \times 5 \frac{3}{4}"$
(d) $3 \frac{5}{8}" \times 6"$

(b) $3 \frac{1}{2}" \times 5 \frac{3}{4}"$

(c) $3 \frac{1}{2}" \times 6"$

3. $C = \underline{\hspace{1cm}}$
 (a) $3\frac{1}{2}'' \times 3\frac{1}{2}''$ (b) $3\frac{5}{8}'' \times 3\frac{5}{8}''$ (c) $3\frac{3}{4}'' \times 3\frac{3}{4}''$
 (d) $3\frac{5}{8}'' \times 3\frac{3}{4}''$
4. $D = \underline{\hspace{1cm}}$
 (a) $1\frac{5}{8}'' \times 3\frac{1}{4}''$ (b) $1\frac{3}{4}'' \times 3\frac{1}{2}''$ (c) $1\frac{3}{4}'' \times 3\frac{1}{4}''$
 (d) $1\frac{5}{8}'' \times 3\frac{1}{2}''$
5. $E_q = \underline{\hspace{1cm}}$
 (a) $3\frac{3}{4}''$ (b) $3\frac{13}{16}''$ (c) $4''$ (d) $4\frac{1}{16}''$
6. $E_r = \underline{\hspace{1cm}}$
 (a) $3\frac{1}{2}''$ (b) $3\frac{5}{8}''$ (c) $3\frac{11}{16}''$ (d) $3\frac{3}{4}''$
7. $E_s = \underline{\hspace{1cm}}$
 (a) $1\frac{3}{4}''$ (b) $1\frac{7}{8}''$ (c) $1\frac{15}{16}''$ (d) $2''$
8. $E_t = \underline{\hspace{1cm}}$
 (a) $9\frac{1}{4}''$ (b) $9\frac{3}{8}''$ (c) $9\frac{1}{2}''$ (d) $9\frac{9}{16}''$
9. $F = \underline{\hspace{1cm}}$
 (a) $3\frac{1}{4}'' \times 3\frac{3}{4}''$ (b) $3\frac{1}{2}'' \times 4''$ (c) $3\frac{1}{2}'' \times 4\frac{1}{16}''$
 (d) $3\frac{5}{8}'' \times 4\frac{1}{16}''$

Choose the option which best answers the question or completes the statement.

- ___ 10. Which is not a true layout guideline?
- When using plate materials, always check for squareness.
 - Generally, layout can start from any corner.
 - Make best use of metal to minimize waste.
 - Place metal where accessible for measuring from as many sides as possible.
 - None of the above
- ___ 11. Which of the following is a poor layout guideline?
- Minimum waste is an important objective.
 - Always double-check every measurement.
 - Cut out major parts first
 - When using templates on patterned materials, it is not necessary to reverse the left or right template.
 - Rough-grind major components before continuing with the layout.

____ 12. A safe rule of thumb with bend allowances is to add to the metal's length ____ .

- a. An amount less than the metal thickness
- b. An amount larger than the metal thickness
- c. An amount larger than the metal thickness for each bend
- d. An amount equal to the metal width for each bend
- e. An amount equal to the metal thickness for each bend

____ 13. List three basic tools required for layout work.

- a.
- b.
- c.

NOTE: Successful completion of assignment sheets, tests and job sheets (except for 2.3) in Units IV and V to a specified level are the student's final evaluation for competency D1: Make layout of material for plate, structural and pipe fabrication.

ANSWERS TO UNIT TEST (D1)

1. c
2. b
3. a
4. b
5. c
6. a
7. d
8. c
9. b
10. b
11. d
12. e
13. Any three of the following:
 - Steel ruler
 - Retractable steel tape
 - Combination framing and try square
 - Bevel or swinging blade protractor
 - Chalk line
 - Metal scribe
 - Bevel square
 - Center punch
 - Wing divider or radius marker

MODULE: PRINT READING, LAYOUT & FIT-UP

UNIT V: LAYOUT ON MATERIAL AND PIPE FABRICATION

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to identify types of fit-up, make pipe layouts and develop templates. This knowledge will be evidenced by achieving the specified score on the unit test.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

- 1.1 Identify the types of fit-up--butted, mitered and notched.
- 2.1 Demonstrate the ability to:
 - a. Develop a template for a two-piece 90-degree turn.
 - b. Develop a template for a 90-degree branch with pipes of equal size.
 - c. Develop a template for a 45-degree branch connection.

MODULE: PRINT READING, LAYOUT & FIT-UP
UNIT V: LAYOUT ON MATERIAL AND PIPE FABRICATION
CONTENTS OF THIS UNIT

- A. Objective sheet
- B. Notes to the instructor
- C. References
- D. Lesson plans
 - 1. Lesson 1: LAYOUT ON MATERIAL AND PIPE FABRICATION
 - a. Information outline
 - b. Transparency masters
 - TM 1.1: Welding angle iron to angle iron
 - TM 1.2: Welding channel iron to channel iron
 - TM 1.3: Welding S or WF beams to S or WF beams
 - 2. Lesson 2: PIPE FABRICATION LAYOUT
 - a. Information outline
 - b. Handout
 - HO 2.1: Manufactured welding fittings
 - c. Job sheets
 - JS 2.1: Develop a template for a two-piece 90-degree turn
 - JS 2.2: Develop a template for a 90-degree branch with pipes of equal size
 - JS 2.3: Develop a template for a 45-degree branch connection
- E. Unit test
- F. Answers to unit test

REFERENCES

- A. Books
 - 1. Franklin, Thomas W. Pipe Fitters Handbook. Encino, Calif.: Glencoe Publ. Co., 1984.

B. Curriculum guide

1. Fortney, Clarence, and Mike Gregory. Blueprint Reading and Layout for Welding. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.

NOTES TO THE INSTRUCTOR

A. Suggested approaches for teaching this unit

1. The unit test is a pre-requisite for JS 2.3
2. Students should demonstrate safe, proper set-up for making different types of fit-ups on structural shapes.

B. Suggested student activities

1. Have students lay out any pipe joint on pipe. After instructor inspection, cut with oxyacetylene torch and bevel; heat and bend to produce pipe joint.

C. Suggested supplemental materials

1. Fortney, Clarence, and Mike Gregory. Blueprint Reading and Layout for Welding. Stillwater, Okla.: Mid-America Vocational Curriculum Consortium, Inc., 1984.
2. Franklin, Thomas W. Pipe Fitters Handbook. Encino, Calif.: Glencoe Publ. Co., 1984.
3. Videotapes from The Media Center, State Fair Community College, Sedalia, Mo.
 - a. Hopper Layout and Fit-Up, Part I (W-88-212)
 - b. Hopper Layout and Fit-Up, Part II (W-88-213)

MODULE: PRINT READING, LAYOUT & FIT-UP

UNIT V: LAYOUT ON MATERIAL AND PIPE FABRICATION

LESSON 1: LAYOUT OF STRUCTURAL SHAPES, ANGLE IRON, CHANNEL IRON AND S OR WF BEAMS

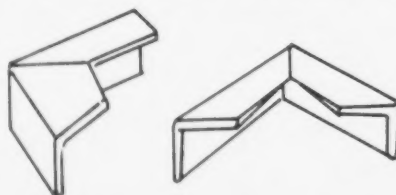
I. Types of fit-up

A. Butted

1. Material is cut off square at the end to be joined.
2. Pieces are then placed together (after beveling, if required) and welded.

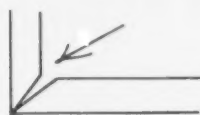
B. Mitered

1. Mitering can be done at any given angle ($22\frac{1}{2}$, 45, $67\frac{1}{2}$, 90, etc.).



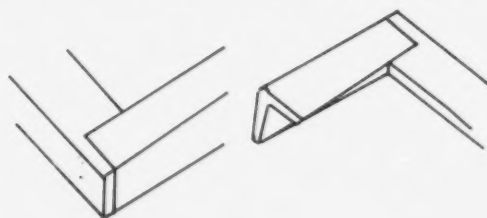
2. A great deal of caution must be taken when mitering two pieces.

- a. Correct angle when mitered edges are placed together
- b. No excessive gaps, which make welding more difficult



C. Notched

1. Notching is similar to the butted fit-up except that a part or portion of one or more pieces is removed to achieve strength, alignment and exact shape.



2. Notching is more difficult and time consuming than butted fit-up but is sometimes required for the proper end result.

II. Procedures for fit-up of structural shapes (same or different sizes)

A. Angle iron (TM 1.1)

1. Butted
2. Mitered
3. Notched

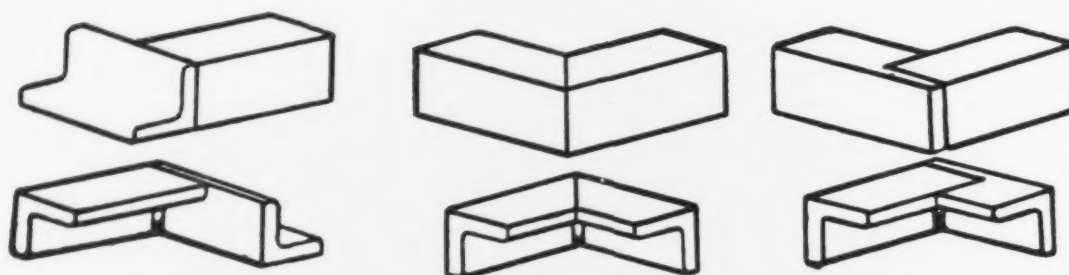
B. Channel iron (TM 1.2)

1. Butted
2. Mitered
3. Notched

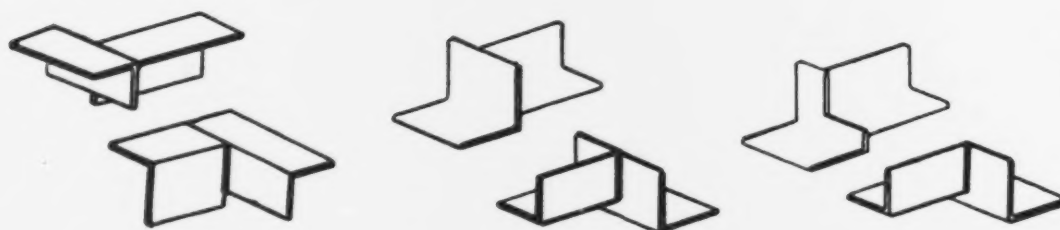
C. S or WF beams (TM 1.3)

1. Butted
2. Mitered
3. Notched

WELDING ANGLE IRON TO ANGLE IRON

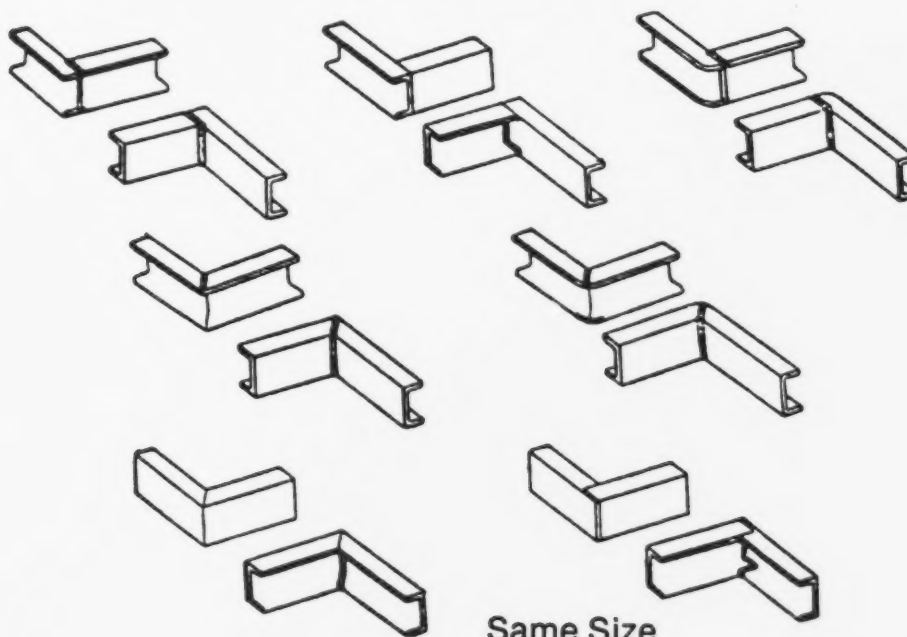


Same Size

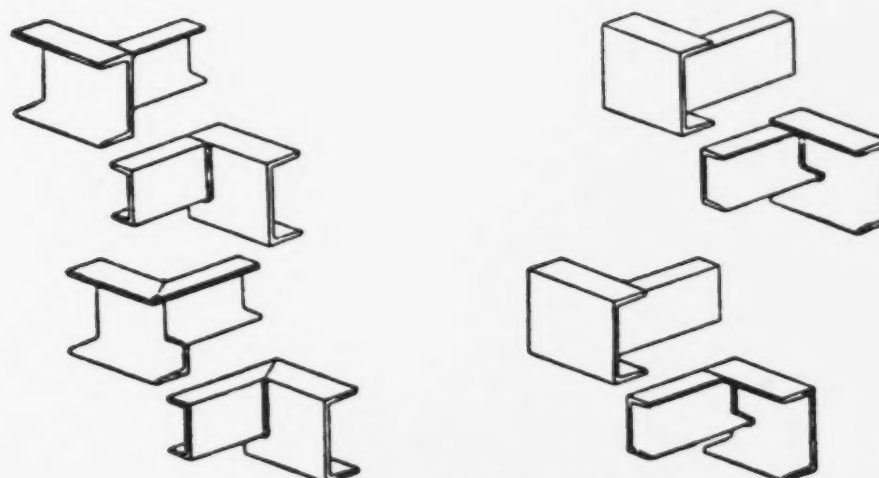


Different Sizes

WELDING CHANNEL IRON TO CHANNEL IRON



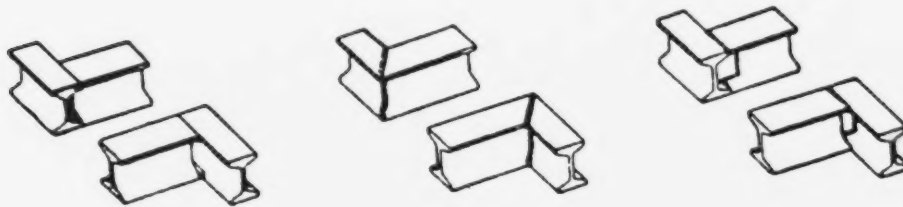
Same Size



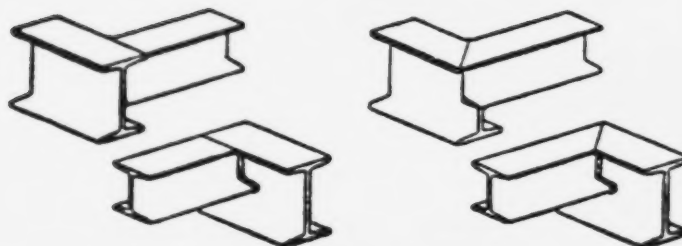
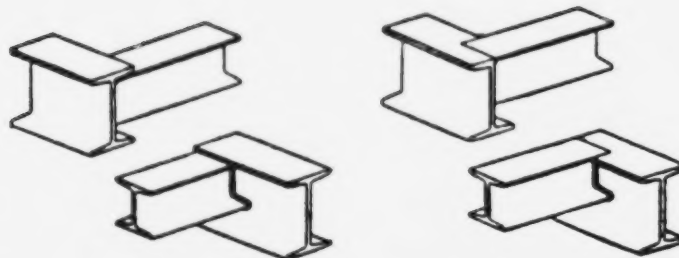
Different Sizes

Courtesy Lincoln Electric Company

WELDING S (SINGLE FLANGE) OR WF (WIDE FLANGE) BEAMS



Same Size



Different Sizes

Courtesy Lincoln Electric Company

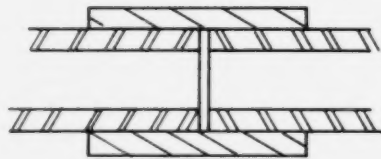
MODULE: PRINT READING, LAYOUT & FIT-UP
UNIT V: LAYOUT ON MATERIAL AND PIPE FABRICATION
LESSON 2: PIPE FABRICATION LAYOUT

I. Square butted joint pipe layout

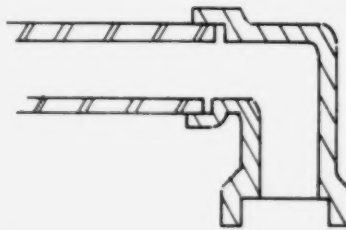
- A. Check ends of pipe for squareness. If excessively out of square, cut to within 1/8" of square and grind to square.
- B. Using pipe jig, angle irons or some form of aligning tool, clamp pipes in place, allowing for any indicated gap.
- C. Tack in place.
- D. Using angle head grinder, bevel pipes to desired or indicated depth, angle, etc.

II. Socket joints

- A. Usually used on 3" pipe or smaller
- B. Pipe to pipe



- C. Pipe to flange or elbow



- D. Socket joints are sometimes unacceptable.
 - 1. Gap or line between pipe and socket can cause crevices and stress corrosion.
 - 2. Incomplete fusion at end of welded pipe can occur.

III. Welded fittings

- A. Available in many sizes, shapes and thicknesses

B. Combine best characteristics for:

1. Unimpaired flow conditions
2. Wide availability
3. Ease of welding
4. Maximum strength

C. Saves time in fabrication

D. Enhances appearance of job

IV. Special fabrications

A. Sometimes manufactured welded fittings are not available and must be made.

B. A variety of designs can be fabricated when necessary.

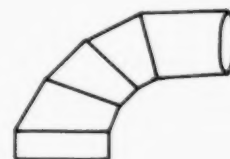
1. Ls or elbows



Three-Segment

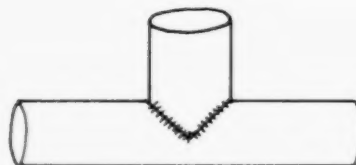


Four-Segment

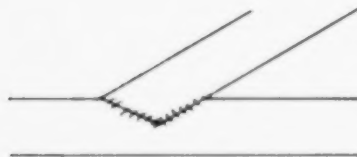


Five-Segment

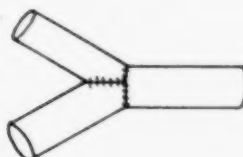
2. Ts



3. Lateral



4. Ys



- C. Joints should be laid out with templates and standard layout curves.
- D. Fittings can be made from straight lengths of pipe by hand, by machine flame cutting or by abrasive cutter (i.e. saws, etc.).

MANUFACTURED WELDING FITTINGS

 90° Long Radius Elbow	 90° Short Radius Elbow	 45° Long Radius Elbow
 Straight Tee	 Reducing Outlet Tee	 Straight Cross
 Cap	 Reducing Elbow	 Welding Neck Flange
 Slip-on Flange	 Lap Joint Flange	 180° Long Radius Return
 Concentric Reducer	 Eccentric Reducer	 Lap Joint Stub End
 Threaded Flange	 Blind Flange	 Welding Neck Orifice Flange

DEVELOP A TEMPLATE FOR A TWO-PIECE 90-DEGREE TURN

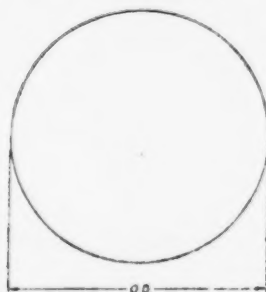
Equipment:

Retractable measuring tape
 Framing square
 Steel rule
 Soapstone marker
 Template material as selected by instructor
 Pipe as selected by instructor
 Drawing pencil
 Construction paper, scissors and tape
 Wing dividers

Procedure:

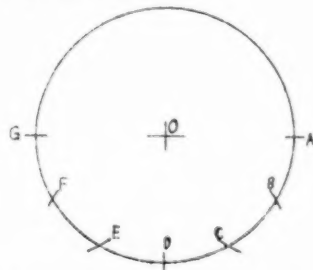
Evaluation
 3 2 1 N

1. Position construction paper on a flat working surface with the selected pipe nearby. Measure the outside diameter of selected pipe.
2. Adjust wing dividers and draw a circle equal to the diameter of the pipe.
 Example:



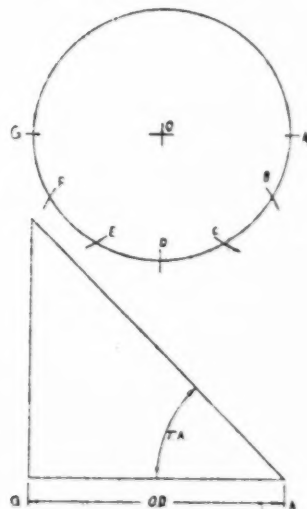
3. Divide the bottom half the circle into six equal parts according to the following procedure.
 - a. Draw a line through the center to find points G, O and A.
 - b. Use point A as a center and the distance A-O as a radius and swing an arc to create point C.
 - c. Use point G as a center and the distance G-O as a radius and swing an arc to create point E.
 - d. Bisect the arc of the circle between points E and C to create point D, then connect points D and O with a vertical line.

- e. Use point D as a center and the distance D-O as a radius and swing arcs left and right to create points F and B.
- f. Use the distance G-F as a radius and check lower half of circle to make sure the six parts are equal.



4. Move to a convenient distance below the circle and draw a horizontal line equal in distance to the O-D of the pipe so that the ends of the G-A vertical lines are in line with the ends of the G-A line across the circle.
5. Use the vertical line as reference and create a template angle for the pipe turn.

NOTE: Since the required angle is 90 degrees, half that angle would be 45 degrees.



6. Draw vertical lines down from all points on the half circle so that they intersect T-A, then letter points connecting to the half circle.
7. Determine the circumference of the pipe by multiplying the diameter of the pipe by 3.141.

12. Draw lines to connect the intersecting points above the extension lines to complete the curve for the 90-degree turn.

— — — —

13. Cut the pattern out and tape it together to form the 90-degree turn.

— — — —

14. Ask instructor to check your work.

— — — —

NOTE: At this point, your instructor may direct you to transfer the pattern to template material, using the template to mark selected pipe properly.

15. Prepare for next job sheet or check in tools and materials. Clean area.

— — — —

Average of above evaluation*

— — — —

*This average is the student's partial evaluation for competency D1: Make layout of material for plate, structural and pipe fabrication.

NOTE: JS 2.1 must be completed to specified level before advancing to JS 2.2.

DEVELOP A TEMPLATE FOR A 90-DEGREE BRANCH WITH PIPES OF EQUAL SIZE

INSTRUCTOR'S NOTE: The unit test should be completed satisfactorily before this job sheet is attempted.

Equipment:

Retractable measuring tape
Framing square
Steel rule
Soapstone marker
Template material as selected by instructor
Pipe as selected by instructor
Drawing pencil
Construction paper, scissors, and tape
Wing dividers

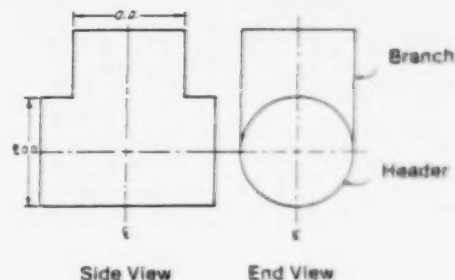
Procedure:

1. Position construction paper on a flat working surface with the selected pipe nearby. Measure the outside diameter (OD) of selected pipe.
2. Use the O-D as the reference dimension and lay a center line long enough that side and end views of the branch can be constructed side by side.

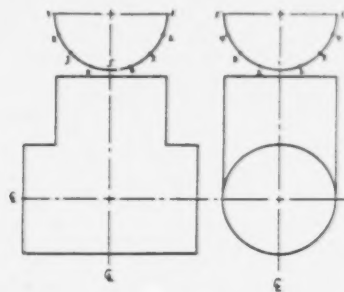
Evaluation
3 2 1 N

— — — —

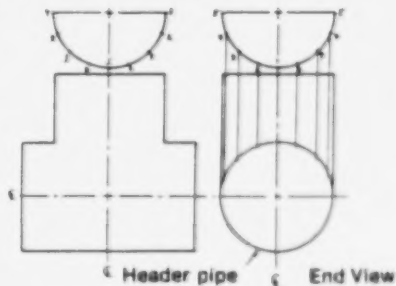
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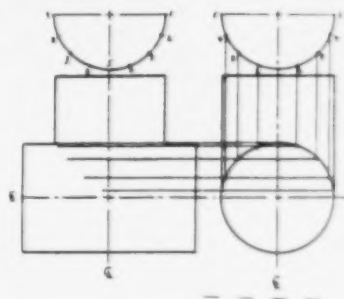
3. Draw half circles directly above the end and side views, divide half circles into eight equal parts and number as illustrated.



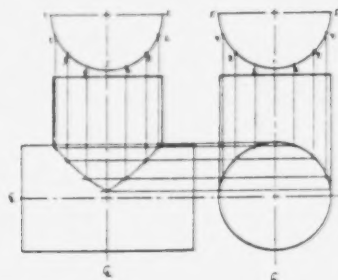
4. Use a square and draw vertical lines down from each point on the half circle above the header until they intersect points on the circumference of the header pipe.



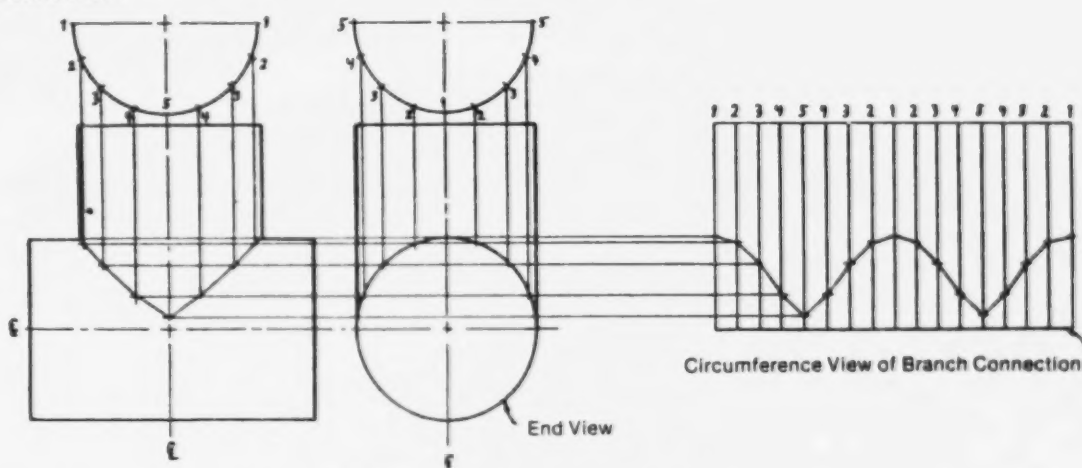
5. Transfer lines from the intersecting points on the circumference of the header to the side view.



6. Use a square and draw vertical lines down from each point on the half circle above the side view until they intersect the lines just transferred from the end view.

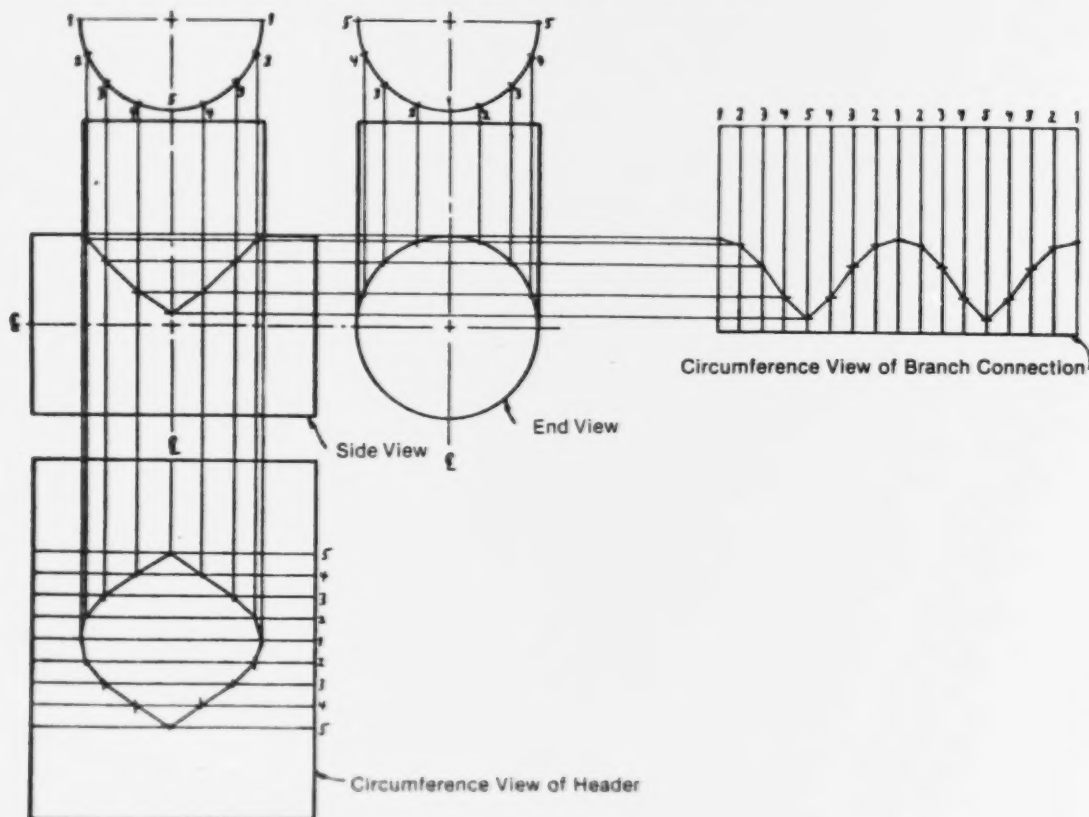


7. Draw an extension line to the right of the horizontal center line of the end view so that the line is equal to the circumference of the branch connection.



8. Form a rectangle with the extension line as the base so that the sides are equal to the height of the branch connection.
9. Divide the extension line into 16 equal parts. Extend vertical lines to the top of the rectangle and number as indicated.
10. Transfer the horizontal lines from both the side and end views to the right so that they intersect the vertical lines in the rectangle at numbered points corresponding to the numbered points in the side and end views.
11. Connect the points of intersection with a line.

12. Draw directly below the side view a rectangle that is equal in length to the circumference of the header pipe (see illustration that follows).



13. Divide the rectangle below the side view into eight equal parts and number as indicated.
14. Transfer lines from the side view down vertically so that numbers in the side view correspond with numbers in the rectangle below the side view.
15. Connect the points of intersection with lines on each side of the vertical center line of the rectangle.
16. Cut out both angular shapes formed in the rectangles and tape them together to check your work's accuracy.
17. Ask the instructor to check your work.

NOTE: At this point, the instructor may direct you to transfer the pattern to template material, using the template to lay out selected pipe properly.

18. Check in tools and materials and clean area or prepare for next job, as directed by your instructor.

Average of above evaluation*

*This average is the student's partial evaluation for competency D1: Make layout of material for plate, structural and pipe fabrication.

DEVELOP A TEMPLATE FOR A 45-DEGREE BRANCH CONNECTION

Equipment:

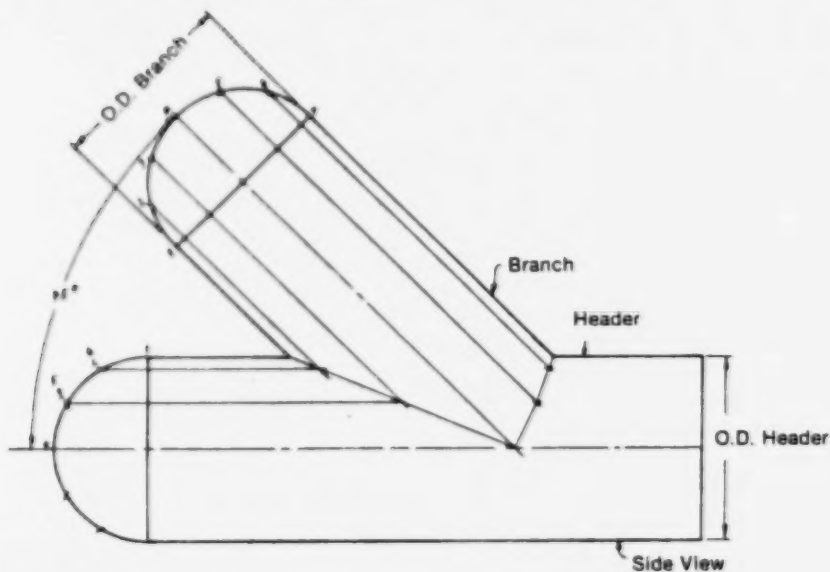
Retractable measuring tape
 Framing square
 Steel rule
 Soapstone marker
 Template material as selected by instructor
 Pipe as selected by instructor
 Drawing pencil
 Construction paper, scissors and tape
 Wing dividers

Procedure:

Evaluation
 3 2 1 N

1. Position construction paper on a flat working surface with the selected pipe nearby. Measure the OD of the selected pipe.
2. Use the OD as the reference dimension and lay out a rectangle to represent the header with each end equal to the OD.

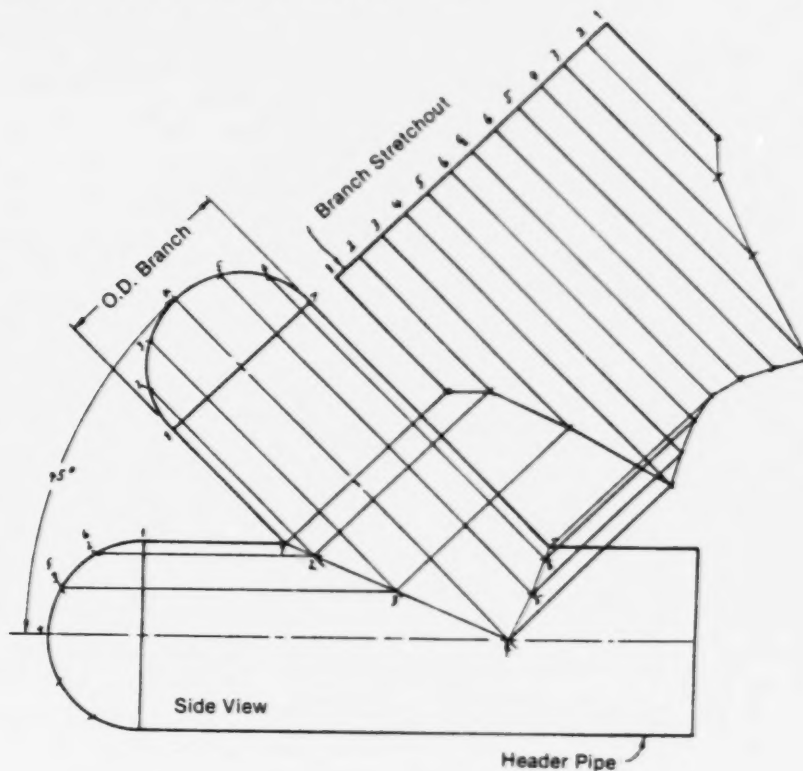
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3. Draw a half circle at the left end of the header. Divide into six equal parts and number as indicated.
4. Project points on the half-circle across the side view of the header.
5. Draw the stretchout of the branch connection equal to the circumference of the pipe and extend at a 40-degree angle above the header.

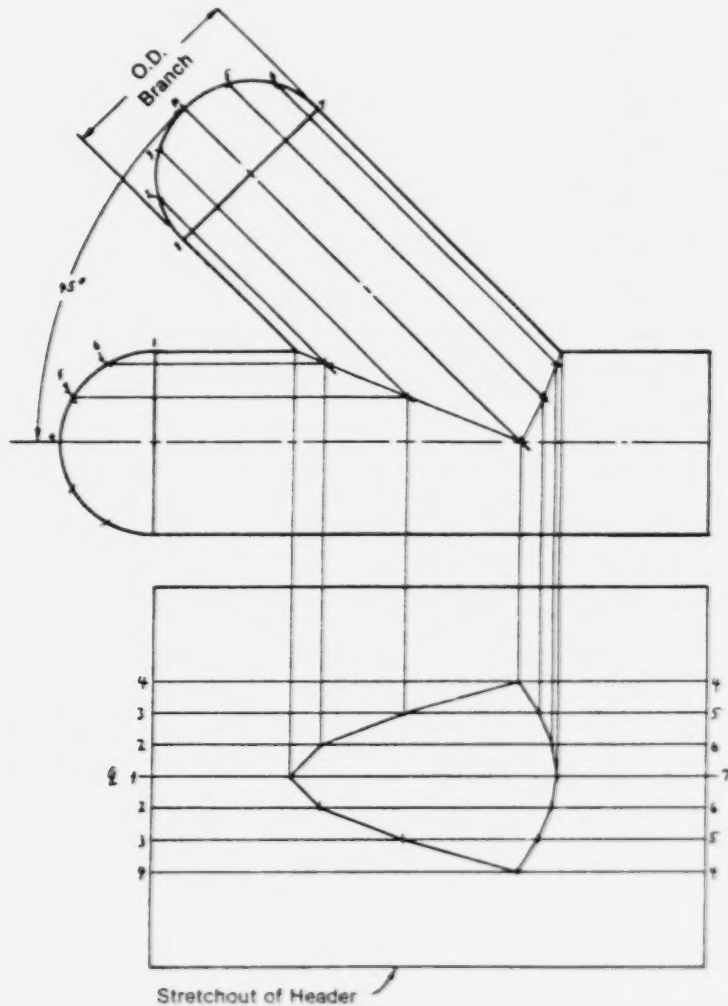
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6. Draw a half circle above branch stretchout; divide into 12 equal parts; number as indicated. — — — —
7. Extend points on the branch half-circle down at a 45-degree angle so that they intersect the horizontal lines on the header. — — — —
8. Connect intersecting points on the header with a line. — — — —



9. Draw the stretchout for the branch connection to the right of the half-circle on the branch connection so that the stretchout equals the circumference of the pipe. — — — —
10. Make extension lines from header and branch as indicated and divide branch stretchout into 12 equal parts. — — — —
11. Extend lines down across the branch stretchout to intersect lines extended from the header and branch. — — — —
12. Connect intersecting points on the branch stretchout with a line. — — — —

13. Draw the stretchout for the header just below the side view so that the stretchout is equal to the circumference of the header.



14. Find the center line of the header stretchout, then divide header stretchout into six equal parts with an equal number above and below the center line.
15. Transfer the numbered points on the side view down to the header stretchout so that they intersect corresponding points on the stretchout.
16. Connect points of intersection on the header stretchout with a line.
17. Cut out header and branch stretchouts, taping them together to check the accuracy of your work.

18. Ask the instructor to check your work.

— — — —

NOTE: At this point, the instructor may direct you to transfer the pattern to template material and use the template to lay out selected pipe properly.

19. Check in tools and materials and clean area or prepare for next job sheet, as directed by your instructor.

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Average of above evaluation*

— — — —

*This average is the student's final evaluation for competency D2: Prepare material for weld procedure.

MODULE: PRINT READING, LAYOUT & FIT-UP
UNIT V: LAYOUT ON MATERIAL AND PIPE FABRICATION
UNIT TEST

Identify these types of fit-up by matching the illustration to its type.

___ 1.



a. Butted

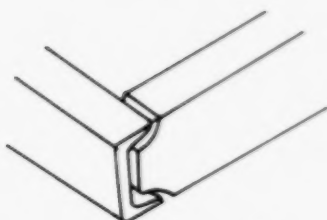
b. Mitered

c. Notched

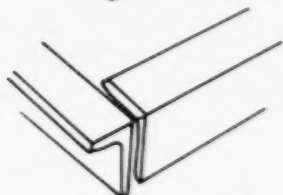
___ 2.



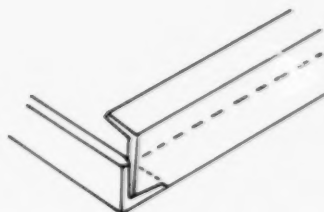
___ 3.



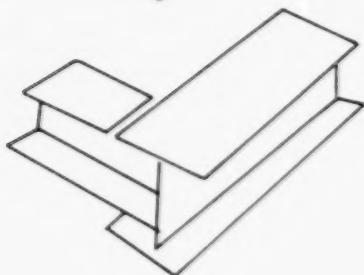
___ 4.



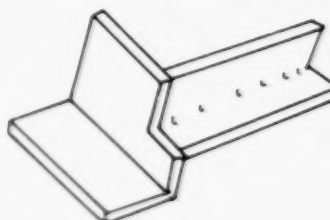
___ 6.



___ 5.



___ 7.



NOTE: Successful completion of assignment sheets, job sheets (except for JS 2.3) and tests in Units IV and V to a specified level are necessary for final student evaluation of competency D1: Make layout of material for plate, structural and pipe fabrication.

ANSWERS TO UNIT TEST (D1)

1. b
2. b
3. c
4. a
5. c
6. c
7. c